VOL. 8 THIRD QUARTER, 1937 NO. 3

The Philippine Journal of Agriculture

PUBLISHED QUARTERLY BY
THE DEPARTMENT OF AGRICULTURE AND COMMERCE

MANILA
BUREAU OF PRINTING
1937

10891

DEPARTMENT OF AGRICULTURE AND COMMERCE

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THE PHILIPPINE JOURNAL OF AGRICULTURE

Published quarterly by the DEPARTMENT OF AGRICULTURE AND COMMERCE
Editorial Offices: DIVISION OF PUBLICATIONS, Oriente Building, Plaza Calderon de la Barca, Manila
[Entered at the Post Office at Manila, Philippines, as second-class matter]

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SCLEROTIUM WILT OF PEANUT, WITH SPECIAL REFERENCE TO VARIETAL RESISTANCE [1]

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TWENTY-TWO PLATES AND FIVE TEXT FIGURES

The control of plant diseases by immunization is dependent upon the availability of varieties which possess resistance and satisfactory agronomic characters. The object of the investigation reported in this paper was to isolate a pure line variety or strain of peanut, *Arachis hypogæa* Linn., highly resistant, if not immune, to the wilt disease caused by *Sclerotium rolfsii* Sacc. This disease is probably the most destructive malady of peanut known in the Philippines. In spite of the fact that the fungus *Sclerotium rolfsii,* has been recorded on peanut in the Philippines since 1918 (Table 5), there has been no published account

[1] Thesis presented, 1937, to the Committee on Graduate Studies, University of the Philippines, in partial fulfillment of the requirements for the degree of Master of Science. A part of this paper was read before the Fourth Philippine Science Convention on February 25, 1937, Manila, P. I.

[2] The writer desires to express his grateful appreciation to his adviser, Professor José K. Santos, Head, Department of Botany, University of the Philippines, for his interest during the latter part of the work and for his helpful suggestions and criticisms; and to Dr. Gerardo O. Ocfemia, Head, Department of Plant Pathology, College of Agriculture, Los Baños, Laguna, for reading the manuscript. Thanks are also due Mr. Juan O. Unite, of the Plant Breeding Section, Bureau of Plant Industry, for the varieties made available for this study and for his coöperation in laying out the first field experiment.

of peanut wilt prior to October, 1933. The present paper reports mainly the results of trials on relative resistance to *Sclerotium rolfsii* of local commercial varieties and certain exotic forms. This work was started in view of the seriousness of the disease which has not been heretofore carefully studied in the Philippines, the increasing use of peanut in the diet of the Filipinos, and the value of the vines for stock feed and of the root nodules for soil renovation.

Peanuts are grown in small holdings all over the Islands. According to June 30, 1935 figures, the Philippines produced 1,341,410 kilos of peanut valued at ₱316,890 [3]. As this production does not fully cover the needs of the people large quantities of peanut are imported annually from abroad (1,281,172 kilos in 1935 valued at ₱132,409, and peanut oil worth ₱71,123).[4]

In order to increase the production of peanuts in the Philippines it seems necessary to plant peanut both in the wet and in the dry season. At both times of the year, however, peanuts are attacked by Sclerotium wilt and by other diseases and their combined effects may reduce the yield considerably if allowed unchecked. In view of the widespread occurrence of *Sclerotium rolfsii* in the Philippines not only on peanuts but also on many host plants, the use of resistant varieties seems to be the ultimate solution of the control problem. The control of plant diseases by planting resistant varieties is the most economical, most effective and permanent measure.

The possibilities in the Philippines of the peanut industry which is "still in its primeval stage" [5] is very great. As stated above our production of peanuts cannot supply the local consumption so that large quantities are imported annually from other countries. The prospects of good market abroad is said to be bright. According to John D. McCord, president and general manager of the Blue Bar Dessicated Coconut Company, peanut oil is gradually replacing dessicated coconut product in confectioneries in the United States.[6] Bigger and better nuts are also very much in demand.[7]

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[3] Philippine Statistical Review, No. 3, Vol. 3, 1936. Bureau of Printing, Manila.

[4] Figures furnished by the Statistics Division, Department of Agriculture and Commerce.

[5] Manila Daily Bulletin, June 27, 1935.

[6] The Tribune, August 14, 1935.

[7] Manila Daily Bulletin. Ab. Cit.

The investigation reported in this paper was conducted from October, 1933 to December, 1936, inclusive, in the experimental plats of the Bureau of Plant Industry at San Andres, Manila.

REVIEW OF LITERATURE

DISTRIBUTION AND ECONOMIC IMPORTANCE OF THE DISEASE

Of the diseases of peanut in the Philippine, the Sclerotium wilt seems to be the most serious. Losses from this disease are difficult to estimate but it is without doubt greater than that caused by any other peanut disease. The distribution of the disease was reported by Reyes and Ramos(37) in April, 1935, and by Fajardo(14) about the end of the same year.

Field observations made of peanut varieties grown side by side in the plats of the Bureau of Plant Industry Central Experiment Station in the wet season of 1933, showed that Sclerotium wilt (Plate 1) was rampant. Examinations made by Reyes and Ramos(37) in October, 1933, showed that all of the seventeen varieties were affected in degrees of seriousness varying from 5.0 to 50.7 per cent. Plants attacked at an early stage generally produced no peanuts and those infected after peanuts have developed pods usually failed to mature. Pods which have already reached maturity may be infected both externally (Plate 2) and internally (Plate 3). In some cases only one or more wilted shoots occur in a hill, while in others entire hills (Plate 1) may be killed. While the disease is very common during the wet season, it also causes considerable injury during the dry season.

In the Philippines, Reinking(34) reported a *Sclerotium* causing a rot of the basal portion of the stems and of the root of peanut. According to this author the disease usually causes no great damage. Pereira(32) isolated a species of *Sclerotium,* probably *S. rolfsii,* from peanut, rice, carrots and sugar cane. Fajardo(14) reported percentages of infection in certain places in Luzon, Philippines, varying from "a trace to 50 per cent" on "tomatoes, peanuts or beans," and "5 to 20 per cent" on "tomato, peanuts and eggplants."

In other countries considerable losses on peanut have been attributed to the ravages of *Sclerotium rolfsii.* In the United States, Wolf (1914)[8], McClintock(22), and Beattie and Beattie(5) are in full accord in regard to the economic importance of *Sclerotium rolfsii.*

[8] Cited by Miller and Harvey (23).

To Saccardo(40) belongs the credit for having first recorded the genus *Arachis* as a host of *S. rolfsii.* According to Peltier(31), however, the first report of the occurrence of the Sclerotium disease of peanut was made by Rolfs from Florida in 1893. Peltier(31) first reported an outbreak of this fungous disease on cultivated perennials in the northern United States. Nine years after Rolfs found the fungus in Florida, Saccardo(40) described it as a new species, *Sclerotium rolfsii.*

In 1914, F. A. Wolf of the Alabama Agricultural Experiment Station reported a fruitrot of peanuts caused by *Sclerotium rolfsii* Sacc.[9]

McClintock(22) reports wilted peanuts at the Virginia Truck Experiment Station also caused by *S. rolfsii.* This author believes that the fungus must have been introduced with imported seeds. The Sclerotium disease of peanut was first observed in Virginia in 1913 and the number of diseased plants increased subsequently every year thereafter. In 1916, the disease caused 15 per cent of wilting of Valencia variety grown in the experimental plats.

In the United States, Anderson(1) attributed to *Sclerotium rolfsii* the stem rots of some 44 economic plants. The same author reported that *S. rolfsii* is common on peanuts in southern States. In 1931, Beattie and Beattie(5) attributed as much as 10 to 15 per cent of losses of peanut pods to root rot caused by *S. rolfsii.* In 1932, Miller and Harvey(23) state that this disease has been overlooked in Georgia as a common cause of root and stem rot of peanut.

Brief scattered reports of the occurrence of this peanut disease in other peanut-growing countries give but scant estimates of losses. According to Maublanc(21) peanut in the French colonies in West Africa is attacked by *S. rolfsii.*

In 1925, the Department of Agriculture in South Africa(2) reported severe outbreaks of wilt of groundnuts due to *Sclerotium rolfsii* in Transvaal.

Shepherd(41) in 1926 mentioned the occurrence on groundnuts in Mauritius of a fungus resembling *Sclerotium rolfsii.*

Rhind(38) in 1927 stated that *S. rolfsii* attacks peanut in damp localities in Burma. In the same year, peanut wilt caused by *S. rolfsii* was recorded by Hansford(15) in Uganda. Leefmans(19) reports that this fungus causes as much as 10 per cent damage to peanuts in the Netherlands Indies.

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[9] Cited by Miller and Harvey (23).

Bertus(6) reports *Sclerotium rolfsii* on groundnut in Paradeniya, Ceylon. The fungus attacks the plants at ground level or above it, causing the leaves and stalks to wither. From his inoculation experiments Bertus concluded that *S. rolfsii* causes stem infection only when a humid atmosphere prevails. He further concludes that generally the fungus is a weak parasite and does not affect underground parts.

Thompson(44) in 1928 reported *S. rolfsii* in Malaya and groundnut was among its hosts listed.

In Sierra Leone in 1929, Deighton(11) stated that *S. rolfsii* attacks peanut in several localities.

In Guatemala, Palm(27) reported in 1932 that groundnuts are attacked by *S. rolfsii.* In Madagascar in the same year, Bouriquet(9) reported *S. rolfsii* as a disease of groundnut as early as 1929.

Marchionatto(20) observed groundnuts attacked by *S. rolfsii* in the Argentine since 1929.

Although *Sclerotium rolfsii* has a worldwide distribution, there seems to be a meager account of the disease and losses that it causes on peanut. In European countries there seems to be no reference in the literature to Sclerotium wilt of peanut. The geographical distribution of the fungus, however, points to the fact that the wilt is an important disease of peanut. It further shows how varied are the conditions and climes under which the fungus can exist, and how numerous are its hosts.

EFFORTS DIRECTED TO CONTROL THE DISEASE

Very little attention has been given to diseases of peanut in the Philippines especially in regard to control measures. This situation accounts partly for the spread of the *Sclerotium rolfsii* disease with greater or less severity each year.

In the Virginia Truck Experiment Station, McClintock(22) reports that a rotation of more than three years is not sufficient to starve out *Sclerotium rolfsii* in the soil. In a test of six varieties for resistance conducted in a soil badly infested with *S. rolfsii* the same author found that Valencia was the most susceptible, and that the order of resistance of the other varieties are Spanish, Tennessee Red, and Virginia Bunch, while Virginia Runner, African, and Hog Goober (*"Worandzia subterranea"*) were practically immune.

Miller and Harvey(23) recommend that the best method of controlling the disease is by the cultivation of resistant varieties, like Alabama Runner in place of susceptible White Spanish.

From the results of his field observation and inoculations, Bertus(6, 7) recommends certain eradicatory measures, such as the burning of diseased plants *in situ;* collection and burning of dead or decaying vegetable matter; and burying the sclerotia in holes or trenches to a depth of 9 to 12 inches.

Beattie and Beattie(5) recommend crop rotation with corn, cowpeas, rye and clover, but not with cotton, sweet potato, potatoes, tomatoes, or cucumbers.

MATERIALS AND METHODS

VARIETIES AND STRAINS USED AND THEIR SOURCES

As a result of encouraging field observations made by the writer in October, 1933, and in 1934, an attempt was made in 1934, 1935 and 1936 to determine definitely whether or not differences in resistance to *Sclerotium rolfsii* exist in peanut varieties. From a total of seventeen varieties observed for the presence of *Sclerotium rolfsii* infection in the wet season of 1933, twelve varieties were used (1) for showing less disease infection, (2) for giving fairly good yields, (3) for having desirable type of kernel and color of seed coat, (4) for habit of growth, or (5) for exhibiting luxuriant green foliage. No consideration was given to oil content or seed dormancy in making the preliminary selection.

The seeds of varieties used in all experiments (Table 1) were raised by and obtained from Mr. Juan O. Unite of the Plant

TABLE 1.—*Origin of the peanut varieties used for the experiments recorded in this paper and their habit of growth*

Variety, number and name	Date of introduction	Source	Habit of growth
1. Biit	1930	Pangasinan	Decumbent
2. Cagayan No. 1	1923	Tuguegarao, Cagayan	Do.
3. Georgia Red	Mar. 24, 1933	Oneco, Florida, U. S. A.	Do.
4. Macapno	1923	Lamao Horticultural Station, Limay, Bataan.	Do.
5. San José No. 3	June 3, 1933	Cabanatuan, Nueva Ecija	Do.
6. Spanish	October, 1913	Richmond, Virginia	Do.
7. Tai-tau	May 19, 1933	Lingnan University, Canton, China.	Runner
8. Tirik	1930	Lemery, Batangas	Semi-erect
9. Valencia	June 3, 1922	College of Agriculture, Los Baños, Laguna.	Semi-runner
10. Vigan Lupog	June 3, 1922	----do	Semi-erect
11. Virginia Jumbo	Mar. 24, 1933	Oneco, Florida, U. S. A.	Runner
12. Virginia Jumbo (a)	1930	Lamao Horticultural Station, Limay, Bataan.	Do.
13. White Improved Spanish	Mar. 25, 1933	Oneco, Florida, U. S. A.	Decumbent

Breeding Section, Bureau of Plant Industry. As may be seen in Table 1, six of these varieties are apparently native and six are of foreign origin. Tai-tau variety which was added to the list in the last two tests, was of recent introduction from China. Apparently this is the big-seeded variety which is commonly seen for sale in the Chinese stores. Two varieties, Tai-tau and Virginia Jumbo, and a strain of the latter are of the runner type, while the others are semi-erect, semi-runner, or mostly decumbent in habit of growth.

METHOD OF APPROACHING THE PROBLEM

While the primary object of these studies was to evaluate the relative resistance of peanut varieties to the attack of *Sclerotium rolfsii,* a thorough survey of the losses occasioned by this fungus disease in the field in various parts of the Philippines was also made. Fortunately a fairly good collection of varieties in culture at the Plant Breeding Section of the Bureau of Plant Industry afforded a splendid opportunity for making the necessary field observation, and for comparison of resistance or susceptibility of varieties. Further information in regard to the seriousness of the disease in the field was obtained through the writer's colleagues in the Plant Pathology Laboratory of the Bureau of Plant Industry. This information gave the writer a sufficiently representative opinion of the seriousness of the Sclerotium disease, and the expediency in solving this plant-disease problem.

In order to test the different varieties under partially controlled conditions, a number of isolations of *S. rolfsii,* were made from all sources and from all available varieties. The cultures were previously tested for pathogenicity to see whether or not differences exist among the cultures. For purposes of uniformity, however, only one isolate from a variety showing a fairly high degree of infection was consistently used throughout artificial field-infection tests.

Properly cured seeds were secured for planting according to the field plan shown in Fig. 1. In this figure the arrangement of plats and the distance of planting of varieties listed in Table 1 were followed.

The relative susceptibility of native and introduced peanut varieties to *Sclerotium rolfsii* were tested by artificial inoculation. The peanut varieties used represented different types of growth and maturity periods. Trials were also made at different seasons in order to determine what environmental factors are conducive to the occurrence and severity of the disease.

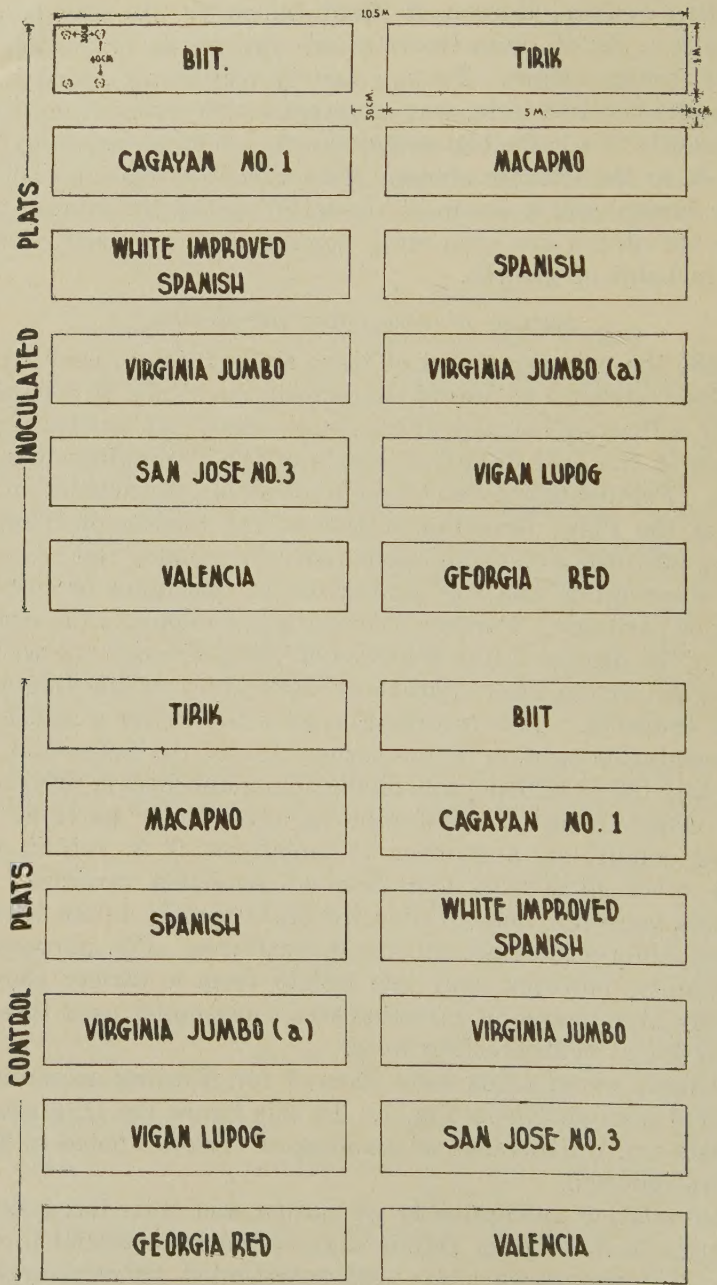


FIG. 1. Plan of the experimental field, showing the arrangement of plats, distribution of the varieties, and distancing. [a]

[a] Tai-tau variety was added to the list in subsequent trials, 1935 and 1936.

In view of the cosmopolitan nature of this soil organism great stress was given to the study of the relative resistance of varieties. Incidentally the relations of cultural practices in vogue and types of soil were also taken into account.

EXPERIMENTS AND OBSERVATIONS

THE DISEASE

Name.—The disease of peanut caused by *Sclerotium rolfsii* has been reported under the names of "wilt," "fruit rot," "sclerotial rot"[10] "sclerotial disease," "stem rot," "blight," "southern blight,"[11] or simply "rot." To distinguish the trouble from other peanut diseases and to avoid confusion, because other organisms also cause wilt of peanut the name "Sclerotium wilt" seems to be the most appropriate. The name is not only the most appropriate because it is more inclusive, simple and clear, but it is also the most tenable because the association of the fungus with wilting is the first and most reliable symptom of infection. An all-inclusive name for this disease should perhaps be "Sclerotium disease of peanut."

General characters.—The general appearance of this disease in the early and advanced stages is shown in Plates 1, 8 and 13. The first symptom of the disease is the wilting of the upper portion of the twigs as if affected by drought. Wilting is followed by drooping of the foliage and losing of the normal green color. The fungus attacks the stems and crown roots near the ground level. The mycelium invades the cortex, girdles the stems, turns it dark brown, permeates the tissues of the stem upwards, and causes the stem to shrink and die. It also invades the underground parts, such as the pegs, pods (Plate 3) and roots. On careful examination shrunken discolored areas may be seen. Under favorable conditions, pods formed near the crown of infected plants are usually covered either partly or wholly with the white mycelium. Plants attacked may be partially or totally infected and never recover.

Branches, leaves and young pods near the surface of the ground are attacked and copious, white, coarse, dense mat of radiating mycelium may be seen on the soil immediately surrounding the infected parts. In a short time, small white spherical bodies form copiously on the surface of the affected tissues. The sclerotial bodies later become buff- or brown-

[10] Cited by Taubenhaus (43). [11] Cited by Stevens (42).

colored. Occasionally, in light soils and during the dry season, the growth of mycelium may be confined to the underground parts of the plant. Sclerotia develop underground near the surface or in crevices. The coarse, white mycelium and the sclerotia of the fungus may also be seen on the shell (Plate 2), or inside the infected, cracked pods (Plate 3). Rotting of the infected cotyledons invariably takes place. In some cases severely infected plants produce no marketable pods.

ISOLATION, PATHOGENICITY, AND IDENTITY OF THE CAUSAL FUNGUS

Isolates from different varieties.—The causative organism was isolated from different wilted varieties of peanuts, scattered in the field. Portions of infected basal parts were cut under aseptic conditions, disinfected, washed and then plated out on potato-glucose agar. From the cottony-white growths that developed, subcultures were made into tubed potato-dextrose agar. Pure cultures were also easily obtained from white, yellow or brown sclerotial bodies adhering to the affected plants.

TABLE 2.—*Isolations of Sclerotium rolfsii Sacc., from peanut varieties and from various places*

Variety	Source	Affected part	Date of isolation
1. Biit	Central Experiment Station, Manila.	stem	Oct. 31, 1933
2. Cagayan No. 1	do	stem	Oct. 31, 1933
3. Georgia Red	do	stem	Oct. 31, 1933
4. Macapno	do	stem	Nov. 2, 1933
5. Tirik	do	stem	Nov. 2, 1933
6. Valencia	do	stem	Nov. 2, 1933
7. Virginia Jumbo	do	stem	Nov. 2, 1933
8. Peanut plant	Antipolo, Rizal	stem	Sept. 2, 1935
9. Peanut plant	Lipa, Batangas	stem	January, 1935
10. Peanut plant	Malinao, Albay	stem	Sept. 22, 1936
11. Peanut plant	Tubigon, Bohol	stem	Nov. 17, 1936

The diseased tissues were placed overnight in sterile chambers supplied with moist cotton and the sclerotial bodies were transferred to steamed rice or cornmeal either with or without sterilization. Both methods proved to be satisfactory although occasional bacterial contaminations were observed. The isolates obtained from the various varieties and their sources are listed in Table 2. All the peanut wilt *Sclerotium* isolated from the different localities and varieties were maintained in pure culture for comparative purposes. They looked so similar in their characteristic features that it was not possible to differentiate

one from another when grown on the same media under laboratory conditions.

Infection experiment.—Artificial infection experiments in the greenhouse using young peanut plants (Plate 6) grown from sterilized seeds in duplicate pots of sterilized soil, and field experiments with pure cultures of the organism proved beyond doubt that the fungus is pathogenic. The inoculation was performed by placing about the same-sized blocks, cut in young plate cultures of the organism, on the soil surface in contact with the stem. The symptoms of the infected plants (Plate 6, figs. 1 and 2) appeared identical with those found on naturally infected peanut plants. The fungus caused wilting and produced copious white mycelium, with distinct radial growth (Plate 6, fig. 1) on the soil surrounding the infected part. Reisolations yielded the same kind of organism. In the greenhouse infection was much slower and caused no material injury probably due to high temperatures and dryness of the atmosphere at the time of the experiment. The peanut plant was found subject to infection during its entire life time, but it is more susceptible during early growth. The organism requires a certain amount of soil moisture and air humidity.

During the dry season peanut plants grown in the greenhouse were infected only partially and with considerable difficulty. In the open, intermittent rains and sunshine facilitated infection. Inocula obtained from young growths, without sclerotia, produced infection much quicker than sclerotial bodies. Wilting is considerably delayed under environmental conditions unfavorable for infection. The same symptoms were produced and the same fungus was reisolated from the sclerotia and diseased tissues of infected plants. The control plants showed no symptoms and signs of the disease whatsoever.

Measurements of sclerotia obtained from pure cultures and from the field.—Cultures of this peanut *Sclerotium* obtained from time to time from diseased plants of different varieties and localities grew readily on various media. In all cases the growth was typical of *S. rolfsii* Sacc. They produced coarse, white, fan-shaped vegetative growth in culture on dapdap (*Erythrina variegata* Linn, var. *orientalis* [Linn.] Merr.) leaves (Plate 4). In a short time, this white mass of mycelia becomes dotted with white tufts originating from a plexus of interlacing hyphae, and finally develop into brown spherical sclerotia. The sizes of the light to dark brown easily detached spherical bodies,

obtained from peanut in the field and from pure cultures (Plate 5), are given in Table 3.

The brown sclerotial bodies on dead tissues of peanut obtained from the field were much smaller than those produced in pure cultures. They measure from 0.28 to 0.99 millimeter. Although the range in size of sclerotia in nature varies to some extent, yet the average size computed on 100 measurements differs only slightly, or 0.50 to 0.56 millimeter.

TABLE 3.—*Diameters of sclerotia based on 100 measurements*

Source	Range		Average
IN NATURE	μ	*mm*	μ *mm.*
Peanut tissues	280–840	0.28–0.84	560.0 or 0.56
Cagayan	360–690	0.30–0.69	500.6 or 0.50
Georgia Red	310–690	0.31–0.69	504.4 or 0.50
Spanish	400–670	0.40–0.67	524.6 or 0.52
Valencia	340–990	0.34–0.99	555.4 or 0.55
IN CULTURE			
Potato-glucose agar	600–2600	0.60–2.60	1,200.0 or 1.20
Sterilized dapdap leaves	500–1400	0.50–1.40	1,390.0 or 1.39

Saccardo's(40) figures for the sizes of sclerotia (0.5–0.8 mm. diameter) of *S. rolfsii,* fall closely within the writer's range of measurements of sclerotia from stems of four varieties.

From pure cultures the sclerotia were much larger having a much wider range and an average of 1.2 millimeters on potato-dextrose agar and 1.39 millimeters on sterilized dapdap leaves (Plate 5). The sizes and shapes of sclerotia of more than thirty cultures of *S. rolfsii* by the writer, varied according to environmental conditions, and chemical or nutritive constituents or reaction of media.

Comparison with authentic cultures and published descriptions.—The growth in pure culture and the morphological characters of the writer's fungus agree very closely with the description by McClintock(22) of *Sclerotium rolfsii* Sacc. on peanuts, especially in regard to size, shape and color of sclerotia. The general appearance of the fungus agrees with the *S. rolfsii* described by Higgins(16) and Taubenhaus(43). The morphologic features of sclerotia, host preference, and behavior in nature are as described by Saccardo(40). It seems unnecessary to redescribe the morphological characters here. According to Pereira,(32) the *Sclerotium* cultures he isolated from peanut, rice, carrots and sugar cane looked so similar that it was impossible

to distinguish one culture from the other when grown under the same conditions. The mycelium was said to have closely similar morphological characters. A comparison of the cultures isolated from peanut and growing on the same medium, at the same age and under identical conditions was made with an authentic culture of *S. rolfsii* Sacc. The authentic culture was kindly supplied by Dr. B. B. Higgins of the Department of Botany, Georgia Agricultural Experiment Station, United States. No well-defined differences, both in mycelial characters and in physiological reactions could be noted. The writer believes that the peanut wilt fungus under discussion is identical with *Sclerotium rolfsii* Sacc.

FIELD OBSERVATIONS

Reports of outbreaks of Sclerotium wilt.—The destructive ravages of this disease in various parts of the Philippines, generally appears in certain localities during the rainy or sultry days of August and September, extending even to the early part of November.

In Albay Province, Assistant Pathologist Melanio R. Calinisan estimated that the disease caused as much as from 60 to 70 per cent of damage. Macario A. Palo, also of the Plant Pathology Laboratory, Bureau of Plant Industry, reported that it is the most common disease of peanut in Batangas Province.

Another evidence of the destructiveness of this peanut disease was learned from Plant Sanitation Foreman Diosdado S. Bongato of the Bureau of Plant Industry, on November 11, 1936. According to Mr. Bongato the disease appeared in Tubigon, Bohol, causing not only wilt and death of peanuts but also decay of the pods.

Percentages of natural infection obtained by actual counts.—In the dry season of 1934 the infection of five varieties of peanuts by *S. rolfsii* in the same field previously planted to peanuts was considerable. Forty-nine days after planting, counts of plants affected with the Sclerotium wilt disease were made at weekly intervals until April 5, 1934. The percentages of infection varied from 31.3 to 50.7 per cent (Table 4) according to the variety. The result tends to show that continuous planting in an infected field increases the incidence of the disease. Although only a few (1–6) hills were severely affected and died completely, the percentage of infection shows that under most favorable conditions the disease may cause a severe damage.

TABLE 4.—*Relative susceptibility of peanuts to S. rolfsii observed under natural conditions*

Variety	Date planted	Number of plants		Per cent infection
		Observed	Infected Apr. 5, 1934 [a]	
Biit	Dec. 8, 1933	69	35	50.7
Macapno	Dec. 8, 1933	66	24	36.3
Spanish	Dec. 8, 1933	65	29	44.6
Tirik	Dec. 8, 1933	67	21	31.3
Virginia Jumbo	Dec. 8, 1933	12	0	.0

[a] Last date of observation.

Evidence of varietal differences in susceptibility to disease.—Practically every one of the seventeen varieties of peanut grown in the wet season of 1933 in the Central Experiment Station of the Bureau of Plant Industry in Manila was attacked by Sclerotium wilt in varying degrees of severity. At the beginning of the rainy weather, plants infected with *Sclerotium rolfsii* were found wilting here and there and in October, 1933 many plants were dead. Fluffy, white mycelial growths were present on newly infected plants and sclerotial bodies were visible around the base of the dying or dead plants, or on the soil which was more or less baked, strongly indicative of its acid condition. Evidence so far obtained, however, indicates that there is considerable difference in susceptibility. The writer noted differences of 5 per cent or more among the various peanut varieties grown side by side during this season at the Central Experiment Station of the Bureau of Plant Industry. Virginia Jumbo, seemed to possess sufficient resistance. In a preliminary selection, five of the seventeen varieties observed in the wet season of 1933 were eliminated. The reason for the elimination was either for undesirability of characters or for susceptibility to *Sclerotium* infection. Twelve varieties were selected and used in disease-resistance experiments.

Methods of dissemination.—The brown sclerotia of the fungus may be around the infected parts, on the soil surrounding the base of the plant, and on fallen leaves and dead stems. The sclerotia drop off easily from dead host tissues and thus on the soil they may be scattered from place to place by water, human beings, animals, implements and other agencies. These sclerotia perennate in the soil for a long period and are reactivated, when climatic and soil conditions become favorable.

These sclerotia together with those which adhere on dead plant tissues are sources of infection in subsequent plantings. As the fungus is soil-borne, it can be readily transferred with the soil from place to place.

Peanut pods and infected stems harboring the mycelium or sclerotia are liable to spread the disease to succeeding crops. Careful selection of well developed seeds from healthy plants is therefore of prime importance. Spread of the fungus from plant to plant may be by contact between diseased stems and leaves and by the mycelium which develops from scattered sclerotia or through the soil, especially if the latter is of light texture.

The fungus sclerotia may also be scattered by farm animals, such as cattle and sheep, for considerable distances. It has been found by Leach and Mead(17) that the sclerotia remain viable after their passage through the digestive tract of such animals. The carabao, and the goat, as well as other farm livestocks, should prove equally dangerous in the introduction of infection into disease-free areas.

Factors affecting occurrence and severity of the disease.— Peanuts are generally grown in most provinces in the Philippines only once a year. The seeds are planted in May or June or after the first showers. In other words peanut is generally a wet season crop, and varieties are sown without regard to whether or not they are early maturing, intermediate, or late, in soils with no tendency to stay wet. Some provinces, however, grow peanuts during the dry season, or where there is a moderate amount of rainfall.

Field observations and inoculations in the greenhouse indicate the influence of environment upon the development of the disease. Like most plant diseases the Sclerotium wilt of peanut occurs more seriously during the wet season than during the dry season. It is probably for this reason that wet season crops occasionally produce lower yields as found in the experiments of Battung(4).

Peanut is subject to infection during its entire life time, although it is more susceptible at the seedling stage. The development and spread of the disease seem to be influenced by the growth of the seedlings. When the growth is below normal, the seedlings are generally more ravaged by the disease than when their growth is rapid. Close planting favors its spread greatly.

During rainy periods the disease is often shown at an early stage by the appearance of white mycelium creeping on the sur-

face of the ground and on the stems of peanut. If favorable weather and soil conditions prevail, the progress of the disease is so rapid that it may kill entire hills (Plate 1) or big areas affecting also the underground parts (Plates 2 and 3). If rainfall is not uniform, the progress of the disease may be arrested for lack of soil moisture and only partial infection occurs. The amount of moisture in the soil and the development of the fungus determine the extent of infection. These factors also determine the spread of the fungus mycelium through the soil, from plant to plant in the row. Plants growing in low wet places are generally severely ravaged by the disease.

Of the many varieties attacked by the disease in the field and of the few sorts artificially inoculated also in the field, all have shown susceptibility to the disease. One or two varieties, however, proved to be comparatively resistant to it.

Light loam soil favors the development of the organism probably because of greater air spaces and of the presence of abundant organic matter. The migration of the fungus from one plant to another or from row to row is facilitated in this kind of soil.

OTHER PLANTS ATTACKED IN THE PHILIPPINES AND ELSEWHERE

The *Sclerotium* fungus causing wilt on peanut is a widespread organism and it attacks a wide variety of host plants including annuals and perennials, herbaceous and woody, important economic crops as well as ornamentals, and weeds. It is most frequently observed on herbaceous and leguminous crops probably by their relative succulence. A list of susceptible species of plants reported by various investigators in the Philippines is given in Table 5.

This list (Table 5) gives a single report on each host infected naturally and only host plants recorded for the first time. The reports of Reinking(34, 35) and also of Pereira (32) did not state definitely the species of *Sclerotium* causing disease on various hosts, but it seems very probable that these authors dealt with *S. rolfsii*. Tisdale(45) confirmed the *Sclerotium* disease of rice in the Philippines as due to *S. rolfsii* Sacc.

In plant disease surveys made by the writer, a few other suscepts may be added to the already known plants reported to be attacked by *Sclerotium rolfsii* in the Philippines. Besides peanut, banana, "buñga ñg tubó" (*Aeginetia indica* Linn.), wheat, eggplant, everlasting, rice, sugar cane, etc., which are already

TABLE 5.—*Host range of Sclerotium rolfsii Sacc. recorded in the Philippines, arranged chronologically and in alphabetical order of the common names.*

Authority	Year reported	Host plants	
		Common name	Botanical name
Reinking (34)	1918	beans	*Phaseolus* spp.
		citrus	*Citrus* spp.
		coffee	*Coffea* spp.
		peanut	*Arachis hypogæa* Linn.
Reinking (35)	1919	alfalfa	*Medicago sativa* Linn.
		African peanut	*Voandzia subterranea* Thou.
		gabi	*Colocasia esculentum* Schott.
		soybeans	*Glycine max* (Linn.) Merr.
		sweet potato	*Ipomœa batatas* (L.) Poir.
		yautia	*Xanthosoma sagittifolium* Schott.
Lee (18)	1922	sugar cane	*Saccharum officinarum* Linn.
		tobacco	*Nicotiana tabacum* Linn.
Pereira (32)	1922	rice	*Oryza sativa* Linn.
Ocfemia (25)	1924	pepper	*Capsicum annuum* Linn.
		tomato	*Lycopersicum esculentum* Mill.
Atienza (3)	1927	apong-apong	*Amorphophallus campanulatus* (Roxb.) Blume
		avocado	*Persea americana* Mill.
		Jerusalem artichoke	*Helianthus tuberosus* Linn.
		patola	*Luffa acutangula* (L.) Roxb.
		sitao	*Vigna sesquipedalis* Fruw.
		squash	*Cucurbita maxima* Duch.
Palo (29)	1928	onion	*Allium cepa* Linn.
De Mesa [a]	1930	bagilumbang	*Aleuritis trisperma* Blanco
Fajardo (12)	1933	amarylli lily	*Hippeastrum* sp.
		Amazon lily	*Eucharis grandiflora* Planch. & Linden
		buñga de China	*Adonidia merrillii* (Becc.) Becc.
		carnation	*Dianthus* sp.
		larkspur	*Delphinium* spp.
		petunia	*Petunia* sp.
		buglelily	*Watsonia* sp.
Fajardo (13)	1934	potato	*Solanum tuberosum* Linn.
Reyes (36)	1934	banana	*Musa sapientum* var. *cinerea* (Blanco) Teodoro
		buñga ñg tubo	*Aeginetia indica* Linn.
		eggplant	*Solanum melongena* Linn.
		everlasting	*Helichrysum bracteatum* Willd.
		wheat	*Triticum vulgare* Vill.
Celino (10)	1936	abacá	*Musa textilis* Née.
		cacao	*Theobroma cacao* Linn.
		corn	*Zea mays* Linn.
		cotton	*Gossypium* sp.
		cutcharitas	*Alternanthera versicolor* Hort.
		dasheen	*Colocasia* sp.
		ikmo or buyo	*Piper betle* Linn.
		indigo	*Indigofera hendecaphylla* Jacq.
		lettuce	*Lactuca sativa* Linn.
		jackfruit	*Artocarpus integra* (Thumb) Merr.
		----------	*Christisonia* sp.

[a] Cited by Celino (10).

listed, it was observed on pink zephyrlily (*Atamosco rosea* [Lindl.] Greene), generally used for border planting, scarlet sage (*Salvia splendens* Ker-Gawl),[12] cassava (*Manihot utilissima* Pohl.), cowpea (*Vigna sinensis* [Linn.] Savi), and on a ground orchid, locally known in Tagalog as "tabu-dapi" (*Spathoglottis plicata* Blume). Mr. M. A. Palo of the Plant Pathology Laboratory, Bureau of Plant Industry, has recently determined the occurrence of *S. rolfsii* on mango (*Mangifera indica* Linn.) and upo (*Lagenaria leucantha* [Duch.] Rusby). Isolations made from these host plants revealed distinct characters and growth habits which cannot be mistaken for *S. rolfsii*.

Other plants which are attacked by the fungus in artificial inoculation were reported by Ramos(33) who found among others, the following to be highly susceptible to *S. rolfsii* attack: casubha (*Carthamus tinctorius* Linn.), cockscomb (*Celosia cristata* Linn.), mustard (*Brassica integrifolia* [West] O. E. Schulz), okra (*Abelmoschus esculentus* [Linn.] Moench.), papaya (*Carica papaya* Linn.), pea (*Pisum sativum* Linn.), pechay (*Brassica cernua* [Thumb.] Forbes and Hemsl.), patani (*Phaseolus lunatus* Linn.), sincamas (*Pachyrrhizus erosus* Linn.) Urban, *Stenolobium stans* (Linn.) D. Don. and *Crotalaria anagyroides* HBK. Palo(30) also produced disease by inoculation with *S. rolfsii* on seedlings of the following plants: ampalaya or amargoso (*Momordica charantia* Linn.), cabbage (*Brassica oleracea* Linn, var. *capitata* Linn.), radish (*Raphanus sativus* Linn.), and other plants used previously by Ramos(33). Investigators in other countries as Ceylon, India (Bertus, 6) reported it to infect artificially many different kinds of plants, especially at the seedling stage. It also causes considerable damage to stored products, such as cassava and sweet potato in the Philippines, and cabbage, Irish potato, pumpkins, squash and sweet potato as reported by Taubenhaus(43) in the United States.

Rolfs(39) of the Florida Agricultural Experiment Station reported its occurrence on beans, cowpeas, eggplant, squash, cabbage, beets and melons among the garden plants; hydrangeas and daphnes among ornamentals; and also on young fig trees and weeds. Taubenhaus(43) compiled its incidence on 32 different hosts in the United States, particularly in the southern part, where the disease is prevalent. Stevens(42) reported its occurrence on 28 or more plants in central and southern United

[12] Host identifications by Mr. E. Karganilla of the National Museum, Bureau of Science, Manila, P. I.

States. Palm and Fulmek(28) listed in Sumatra 21 economic crops, 4 green manures, 6 ornamentals, and 7 weeds as host plants of *S. rolfsii.* In the same year Birmingham(8) of New South Wales also reported its occurrence on 30 different hosts, comprising economic crops, ornamentals and weeds. According to Paintin(26), *Sclerotium rolfsii* is parasitic on about 140 plant species, including major crops. This author also states that the increasing damage due to it makes the problem of control a serious one, especially in the southeastern United States. The latest available report by Weber(46) gives a list of 189 plants found mostly in the United States and other countries. Many of these plants are cultivated in the Philippines.

The importance of enumerating the wide variety of plants, especially crop plants, which are subject to the attack of this pathogenic fungus in the Philippines under natural or artificial conditions of exposures, is to apprize the farmers of the hazards of adapting any ill-advised order of rotation.

TESTS FOR VARIETAL RESISTANCE

As it is humanly impossible to secure a piece of ground in which the soil is absolutely uniform, a method of planting was devised whereby the varieties employed were arranged as shown in Fig. 1. There are also other advantages which accrue from this arrangement, instead of planting the varieties in adjoining or contiguous plats. If more space had been available to increase the number of check plats the differences in soil conditions could have been further reduced.

METHOD OF PLANTING, CARE, AND HARVESTING

The varieties used in disease-resistance experiments were raised by Mr. Unite of the Bureau of Plant Industry. Sound seeds of the same age were used in order to insure uniformity of growth as much as possible in both check and inoculated plats. In subsequent cultures, the seeds were selected from control plants.

The land used for the tests was never planted to peanuts before. It was prepared with the same implements and in the same manner throughout. Plowing was done both ways twice and then it was harrowed after each plowing.

The experimental field was quite level. It was divided into rectangular plats (Plate 7) as shown in the planting plan in Fig. 1. The field was chosen for apparent uniformity of the soil and plats 1 $\times$ 5 meters in size with a path between each

of 65 centimeters wide from side to side and 50 centimeters from end to end. The paths served to preclude interlocking of plants of two different varieties. They also served for drainage, during rainy weather. The planting of the twelve varieties was so arranged that each variety was separated from the adjacent varieties by a dead space, and each variety occurred in one replication of a series. To provide loose earth for the development of the pods the plats were raised about 10 centimeters high. In all cultures the seeds sown were selected for maturity and purity. Plantings were done uniformly by placing three kernels in each hill, except the last one, at a depth of approximately 5 centimeters. The rows were 40 centimeters apart [13] and the hills were 30 centimeters apart in the row. Seasonal plantings were all done in one day.

Both the plats for inoculation and for control received the same treatment in regard to cultivation, weeding and watering. Only occasional watering was done, however. With the exception of the last test, the first two trials were conducted in the same plats.

At maturity, or after the lapse of four months, harvesting was done with spading forks. The plants were gathered and placed in separate paper bags. After examinations and counts were made, the pods were harvested and dried in the sun at equal lengths of time. The harvesting of inoculated and control plats of each variety was done on the same date.

TECHNIC OF INOCULATION

All the inoculation tests were conducted a month and a half after planting. The isolate selected for all inoculation work was obtained from Valencia, a variety which was most susceptible. The use of the fungus from Valencia was made on the supposition that it is probably more virulent than those isolated from the other varieties.

Small thin blocks of uniform size, about 8 millimeters square, were cut with a sharp, flamed scalpel from cultures on plated potato-glucose agar of four to five days of age. With the aid of sterile forceps, a block containing vigorously-growing hyphae was placed on the uninjured base of the plant touching the ground level on every hill. With this procedure approximately 1,200 blocks were required to complete the series of

[13] Wider space, or 60 to 75 centimeters apart between rows, is permissible in commercial plantings in order to admit satisfactory cultivation.

yearly inoculations. All efforts were made in each of the three seasons to accomplish inoculations in one day for uniformity.

The control plats (Plates 9 and 11) were treated exactly the same as the inoculated plats except that no fungus was used. Under extremely unfavorable conditions watering of the inoculated plats was done to start the growth of the fungus. Occasional weeding was done by picking or uprooting them with the aid of a piece of flattened iron bar with a dull edge. A disease similar to that produce in nature was produced by these inoculations. Except in doubtful cases, reisolations were not found very necessary.

METHOD OF GATHERING DATA AND EVALUATING RESISTANCE

At each season observations were made and notes were kept of the date of infections, the number of wilted plants, and finally the number of plants that died and those that survived. Infection was judged by the symptoms and signs of the disease.

The percentage of plants which survived the effects of inoculations was used as an index of resistance. At harvest time, plant counts of each variety were made to determine the percentages of infection. In this work the number of plants that escaped the disease and those that were infected were counted. To secure a comparison of the relative susceptibility of the varieties, the number of diseased pods as well as the number of marketable pods and their corresponding weights were recorded. Counts of germinated pods were also made. To reduce

TABLE 6.—*Results of artificial infection experiment with Sclerotium rolfsii conducted in 1934*

Variety	Initial stand		Number of plants infected [a]		Per cent infection	
	Control	Inoculated	Control	Inoculated	Control	Inoculated
Biit	39	52	0	26	0	50.00
Cagayan No. 1	51	52	0	26	0	50.00
Georgia Red	64	62	0	36	0	58.06
Macapno	48	64	0	33	0	51.56
San José No. 3	65	43	0	25	0	58.13
Spanish	42	51	0	24	0	47.06
Tirik	45	58	0	13	0	22.41
Valencia	51	43	0	35	0	81.39
Vigan Lupog	64	67	0	22	0	32.83
Virginia Jumbo	31	19	0	0	0	0
Virginia Jumbo (a)	33	38	0	1	0	2.63
White Improved Spanish	53	44	0	23	0	52.27

[a] Symptoms suspicious of presence of other organisms were isolated in case of doubts.

errors due to loss of moisture, weighings were always made on the same date.

EXPERIMENTAL RESULTS

Field experiment in 1934.—On April 12, 1934 an experiment was conducted to study the relative resistance of peanut varieties to Sclerotium wilt, by inoculation under field conditions. The results of this inoculation are given in Tables 6 and 7. The comparative susceptibility of the twelve varieties used and the effect of infection on the yield of pods are indicated in these tables.

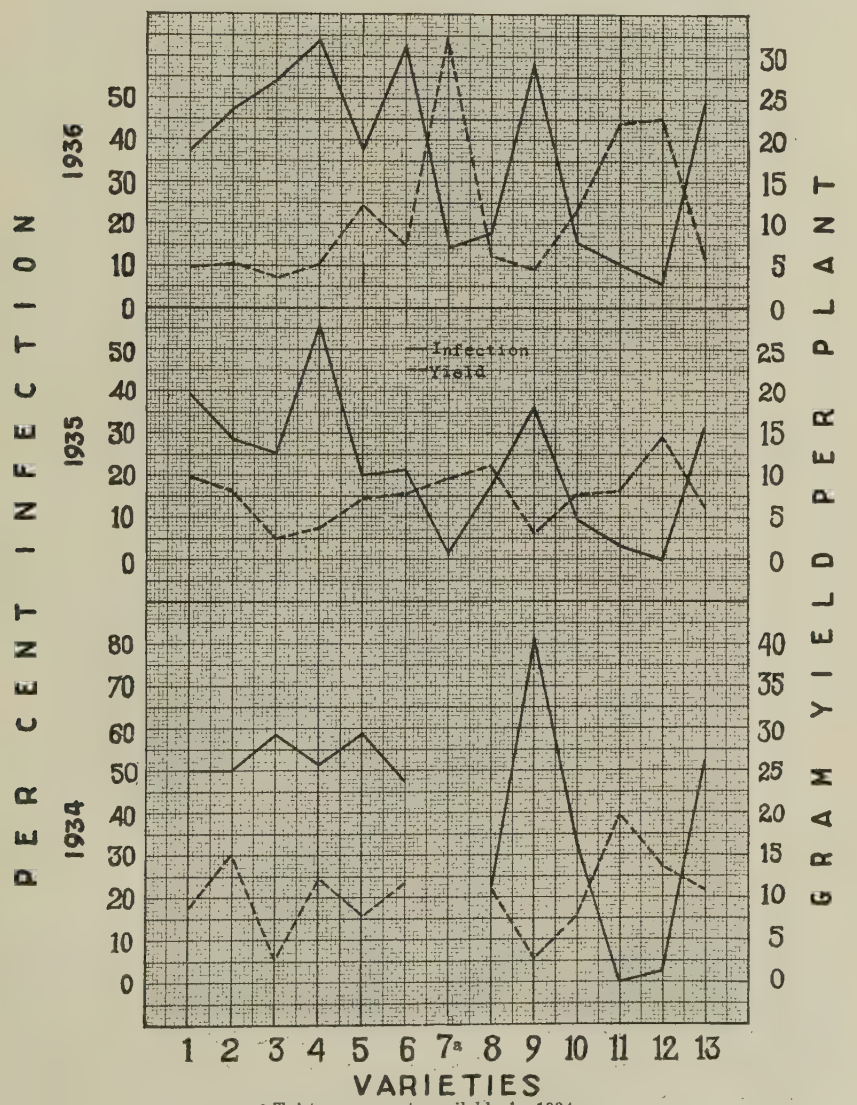
Tables 6 and 7, show the results of a preliminary trial on the relative resistance and yields of different varieties of peanuts.

TABLE 7.—*Showing the yield in pods per plant, and counts of diseased and germinated pods, based on actual number of plants used in 1934*

Variety	Number of plants		Yield in pods (marketable)	
	Control	Inoculated	Control	Inoculated
			Grams	*Grams*
Biit	39	52	615.5	460.5
Cagayan No 1	51	52	779.2	781.6
Georgia Red	64	62	226.0	164.9
Macapno	48	64	801.5	797.0
San José No. 3	65	43	582.0	342.0
Spanish	42	51	736.2	611.5
Tirik	45	58	473.5	642.5
Valencia	51	43	233.5	116.5
Vigan Lupog	64	67	460.0	519.0
Virginia Jumbo	31	19	517.7	379.4
Virginia Jumbo (a)	33	38	513.9	524.0
White Improved Spanish	53	44	743.2	483.5

Variety	Yield per plant (marketable)		Number of diseased pods		Number of germinated pods	
	Control	Inoculated	Control	Inoculated	Control	Inoculated
	Grams	*Grams*				
Biit	15.77	8.85	0	66	52	41
Cagayan No. 1	15.27	15.02	0	42	9	11
Georgia Red	3.53	2.65	0	133	50	54
Macapno	16.69	12.45	0	78	7	20
San José No. 3	8.95	7.93	0	33	32	39
Spanish	17.52	11 99	0	89	11	46
Tirik	10.52	11.07	0	43	85	83
Valencia	4.57	2.70	0	222	97	54
Vigan Lupog	7.18	7.74	0	38	37	21
Virginia Jumbo	16.70	19.96	0	0	0	0
Virginia Jumbo (a)	15.57	13.78	0	0	0	0
White Improved Spanish	14.02	10.98	0	49	42	13

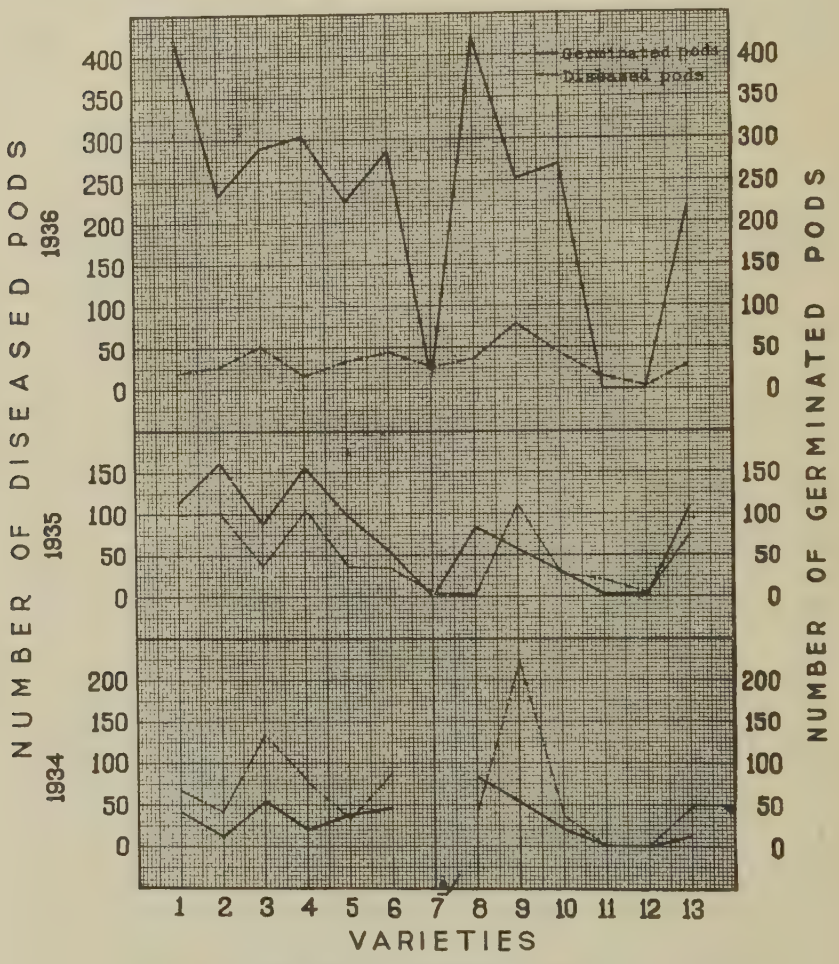
The results (Graph shown in Fig. 2) show striking differences in susceptibility to infection. In the case of very susceptible varieties it was easy to obtain a large number of infection, in progression, although it required a long time. The same symptoms (Plates 8, 10 and 12) as those observed in the field were produced on the inoculated plants and the fungus was readily reisolated. The control plats (Plates 9 and 11) remained



[a] Tai-tau was not available in 1934.

FIG. 2. Representing graphically the effect of artificial inoculation on the yield for the three-year period.

healthy. Under the conditions of the experiment, the varieties, in order of their susceptibility were as follows: Valencia, Georgia Red, San José No. 3, White Improved Spanish, and Macapno. These varieties showed exceedingly high percentages of in-



[a] Tai-tau was not available in 1934.

FIG. 3. Chart showing by year the effect of inoculation on the pods underground.

fection, while Biit, Cagayan No. 1, and Spanish suffered less injuries. Those moderately resistant were Tirik and Vigan Lupog, while Virginia Jumbo(a) and Virginia Jumbo showed notable resistance. The freedom from infection of the last variety, however, may be attributed to fewer number of plants

inoculated or to paucity of inoculum. The virulent behavior of the disease in general seemed to have been enhanced by the acid condition of the soil, the peanut plats varying in hydrogen-ion concentration from pH 5.33 to pH 5.83, and the fungus being an acid-loving organism. Virginia Jumbo(a) is a strain selection which has been in cultivation here for some time, while Virginia Jumbo is of recent introduction. Considerable reduction of yield of nuts resulted from inoculation, except in the three varieties, Tirik, Vigan Lupog and Virginia Jumbo. The number of diseased pods were greater in susceptible varieties than in those affected to a less degree as shown in Fig. 3. In this year's experiment it was noted that the presence of disease accelerated somewhat the germination of pods underground.

Field experiment in 1935.—The second inoculation experiment was conducted during the latter part of 1935, under somewhat disimilar conditions. The same varieties that were planted in 1934 and a Chinese variety, Tai-tau (Plate 16), were grown in the same field used in 1934. The same methods of planting were followed. Inoculations were made on October 7, 1935. In this experiment, precautions were taken in preparing the land so as not to scatter infection from the inoculated plats. The infested plats were again used for the plants to be inoculated. The results of this experiment are given in Tables 8 and 9.

TABLE 8.—*Results of artificial infection experiment with Sclerotium rolfsii conducted in 1935*

Variety	Initial stand		Number of plants infected		Per cent infection	
	Control	Inoculated	Control[a]	Inoculated	Control	Inoculated
Biit	95	84	1	33	1.05	39.28
Cagayan No. 1	94	91	0	26	0	28.57
Georgia Red	69	91	2[b]	23	2.89	25.27
Macapno	86	90	0	51	0	56.66
San José No. 3	47	45	1	9	2.12	20.00
Spanish	93	79	0	17	0	21.51
Tai-tau	78	86	0	1	0	1.16
Tirik	91	93	0	16	0	17.20
Valencia	97	83	1	30	1.03	36.14
Vigan Lupog	90	95	0	9	0	9.47
Virginia Jumbo	96	95	0	3	0	3.15
Virginia Jumbo (a)	89	83	0	0	0	0
White Improved Spanish	85	87	1	26	1.17	31.03

[a] Contaminations believed to have taken place either through mechanical means or naturally.

[b] One plant was infected on lateral stem.

TABLE 9.—*Showing the yield in pods per plant, and counts of diseased and germinated pods, based on actual number of plants used in 1935*

Variety	Number of plants		Yield in pods (marke able)	
	Control	Inoculated	Control	Inoculated
			Grams	*Grams*
Biit	95	84	1,165.5	831.5
Cagayan No. 1	94	91	962.0	748.7
Georgia Red	69	91	224.5	228.0
Macapno	86	90	735.8	354.5
San José No. 3	47	45	230.5	334.7
Spanish	93	79	851.5	628.0
Tai-tau	78	86	654.0	841.5
Tirik	91	93	1,267.5	1,039.7
Valencia	97	83	440.0	259.5
Vigan Lupog	90	95	725.5	738.5
Virginia Jumbo	96	95	943.5	773.0
Virginia Jumbo (a)	89	83	1,290.0	1,224.0
White Improved Spanish	85	87	728.0	534.5

Variety	Yield per plant (marketable)		Number of diseased pods		Number of germinated pods	
	Control	Inoculated	Control	Inoculated	Control	Inoculated
	Grams	*Grams*				
Biit	12.26	9.89	7	99	26	114
Cagayan No. 1	10.23	8.22	0	101	22	162
Georgia Red	3.25	2.50	11	38	55	87
Macapno	8.55	3.93	0	105	29	157
San José No. 3	4.90	7.43	9	37	16	98
Spanish	9.15	7.94	0	35	36	54
Tai-tau	8.38	9.78	0	5	2	1
Tirik	13.92	11.17	0	4	34	84
Valencia	4.53	3.12	7	113	182	58
Vigan Lupog	8.06	7.77	0	28	51	30
Virginia Jumbo	9.82	8.13	0	22	2	4
Virginia Jumbo (a)	14.49	14.74	0	5	0	3
White Improved Spanish	8.56	6.14	4	77	27	109

The results of inoculation experiments in 1935 resemble somewhat in general those obtained in 1934 as to the response of the varieties. There was noted, however, an almost wholesale decrease in the percentages of infected plants which may be attributed partly to the liberal application of hydrated lime, at the rate of 500 kilograms per hectare, applied two months ahead of sowing time. With the exception of Virginia Jumbo (a) all varieties displayed varying degrees of infection. Tai-tau and Virginia Jumbo were the least affected varieties (Fig. 2). These were followed by Vigan Lupog and Tirik (Plate 14). The varieties greatly affected by inoculation were Macapno,

Biit, Valencia and White Improved Spanish, while the others fell in between the two classes. One plant of Georgia Red (check) which was infected on the lateral stem was probably inoculated through mechanical means. A conspicuous decrease in yield was noted in inoculated plats of ten varieties; the susceptible varieties suffered greater damage than the less susceptible ones. As regards diseased and germinated pods (Fig. 3), the figures obtained are in general agreement with those of the experiment in 1934.

Field experiment in 1936.—Field inoculations in the wet season of 1936 were made on September 21, 1936, following essentially the same general plan. Due to some unavoidable circumstances, a new field was opened and made available for the 1936 inoculation experiment. Tables 10 and 11 give the results obtained in 1936.

TABLE 10.—*Results of artificial infection experiment with Sclerotium rolfsii conducted in 1936*

Variety	Initial stand		Number of plants infected		Per cent infection	
	Control	Inoculated	Control[a]	Inoculated	Control	Inoculated
Biit	95	94	0	35	0	37.23
Cagayan No. 1	99	84	1	40	1.01	47.61
Georgia Red	87	70	0	38	0	54.28
Macapno	98	75	3	48	3.06	64.00
San José No. 3	61	82	0	31	0	37.80
Spanish	83	89	0	56	0	62.92
Tai-tau	77	85	0	12	0	14.11
Tirik	85	99	0	17	0	17.94
Valencia	95	90	2[b]	53	2.10	58.88
Vigan Lupog	84	78	2	12	2.38	15.38
Virginia Jumbo	47	59	0	6	0	10.16
Virginia Jumbo (a)	89	88	0	5	0	5.68
White Improved Spanish	74	87	1[c]	43	1.35	49.42

[a] Contaminations believed to have taken place either through mechanical means or naturally.
[b] and [c] Infection took place on lateral stems touching the ground and not at the base.

Owing perhaps to more favorable conditions prevalent during this year's test, all varieties suffered infections in varying degrees. On the whole, however, the order of susceptibility (Fig. 2) approaches somewhat that of 1934 and more closely that of 1935. The results showed the relative resistance of the different varieties to *Sclerotium rolfsii*. More or less consistent results were obtained in the three trials.

A marked reduction of yield of pods resulted from inoculation although this year's production both in pods (Table 11) and in

straw, exceeded the previous tests. The weather and soil conditions evidently favored the germination of more pods (Fig. 3). Although a smaller number of diseased pods was observed this year all varieties yielded diseased pods (Plates 21 and 22). The runner varieties yielded more hay than the erect or semi-erect types, especially during this season. The infection of plants in this type was usually partial (Plates 18, 19 and 20) as in Virginia Jumbo and Tai-tau.

TABLE 11.—*Showing the yield in pods per plant, and counts of diseased and germinated pods, based on actual number of plants used in 1936*

Variety	Number of plants		Yield in pods (marketable)	
	Control	Inoculated	Control	Inoculated
			Grams	*Grams*
Biit	95	94	1,200.3	465.0
Cagayan No. 1	99	84	1,040.4	448.5
Georgia Red	87	70	938.4	257.0
Macapno	98	75	717.5	395.8
San José No. 3	61	82	1,339.8	993.8
Spanish	83	89	757.0	663.8
Tai-tau	77	85	2,705.6	2,754.1
Tirik	85	99	1,093.3	610.0
Valencia	95	90	934.0	407.0
Vigan Lupog	84	78	1,553.4	911.5
Virginia Jumbo	47	59	1,362.5	1,307.0
Virginia Jumbo (a)	89	88	2,350.6	1,999.5
White Improved Spanish	74	87	613.0	510.5

Variety	Yield per plant (marketable)		Number of diseased pods		Number of germinated pods	
	Control	Inoculated	Control	Inoculated	Control	Inoculated
	Grams	*Grams*				
Biit	12.63	4.94	0	19	142	422
Cagayan No. 1	10.50	5.33	10	22	94	233
Georgia Red	10.78	3.67	0	51	226	289
Macapno	7.32	5.27	0	16	114	304
San José No. 3	21.96	12.11	0	34	147	225
Spanish	9.12	7.45	0	44	234	286
Tai-tau	35.13	32.40	0	26	0	14
Tirik	12.86	6.16	0	36	240	424
Valencia	9.83	4.52	9	79	121	252
Vigan Lupog	18.49	11.69	2	43	153	270
Virginia Jumbo	28.98	22.15	0	15	6	0
Virginia Jumbo (a)	26.41	22.72	0	4	0	0
White Improved Spanish	8.28	5.86	3	30	236	219

The results of the three year's experiments are summarized in Tables 12 and 13. According to the results, the percentages of infection varied according to seasonal conditions. This was evi-

dent in the 1936 plat experiment when the intermittent rain and sunshine was followed by more infection than in the preceding years.

TABLE 12.—*Summary of percentages of infection, yield per plant, and reduction in yield due to infection obtained from the three trials (1934, 1935 and 1936)*

Variety	Average infection	Rank of susceptibility	Average yield per plant		Difference	Reduction in yield
			Control	Inoculated		
	Per cent		*Grams*	*Grams*	*Grams*	*Per cent*
Biit	42.17	6	13.55	7.89	5.66	41.77
Cagayan No. 1	42.06	7	12.00	8.85	3.15	26.25
Georgia Red	45.87	3	5.85	2.94	2.91	49.74
Macapno	57.40	2	10.85	7.21	3.64	33.54
San José No. 3	38.64	8	11.93	9.12	2.81	23.55
Spanish	43.83	5	11.93	9.12	0.48	5.00
Tai-tau [a]	7.63	11	14.50	14.06	0.44	3.03
Tirik	19.18	10	12.43	9.46	2.97	23.89
Valencia	58.80	1	6.31	3.44	2.87	45.48
Vigan Lupog	19.22	9	11.24	9.06	2.18	19.39
Virginia Jumbo	4.43	12	18.50	16.74	1.76	9.51
Virginia Jumbo (a)	2.77	13	18.82	17.09	1.73	9.19
White Improved Spanish	44.24	4	10.28	7.66	2.59	25.19

[a] Not available in 1934.

Table 12, showing a three-year summary, gives the average percentage of infection obtained through inoculation of the varieties used. The results are graphically represented in Fig. 4. The destructive effect on nut yield was very substantial. The experiments show conclusively the relative resistance of the varieties of peanuts to *S. rolfsii* infection. The relative response of the different varieties to artificial inoculations during the three-year period was quite consistent. The varieties of peanut arranged in descending order of their susceptibility to infection are as follows: (1) Valencia, (2) Macapno, (3) Georgia Red, (4) White Improved Spanish, (5) Spanish, (6) Biit, (7) Cagayan No. 1, (8) San José No. 3, (9) Vigan Lupog, (10) Tirik, (11) Tai-tau, (12) Virginia Jumbo and (13) Virginia Jumbo (a).

The chart shown in Fig. 5, shows some relation to infection of the number of diseased pods and the number of germinated pods in inoculated plants or varieties. In 1934 the average number of germinated pods was slightly less than in the control varieties (Table 7). In the next two year's experiments, however, the number of germinated pods in the inoculated varieties

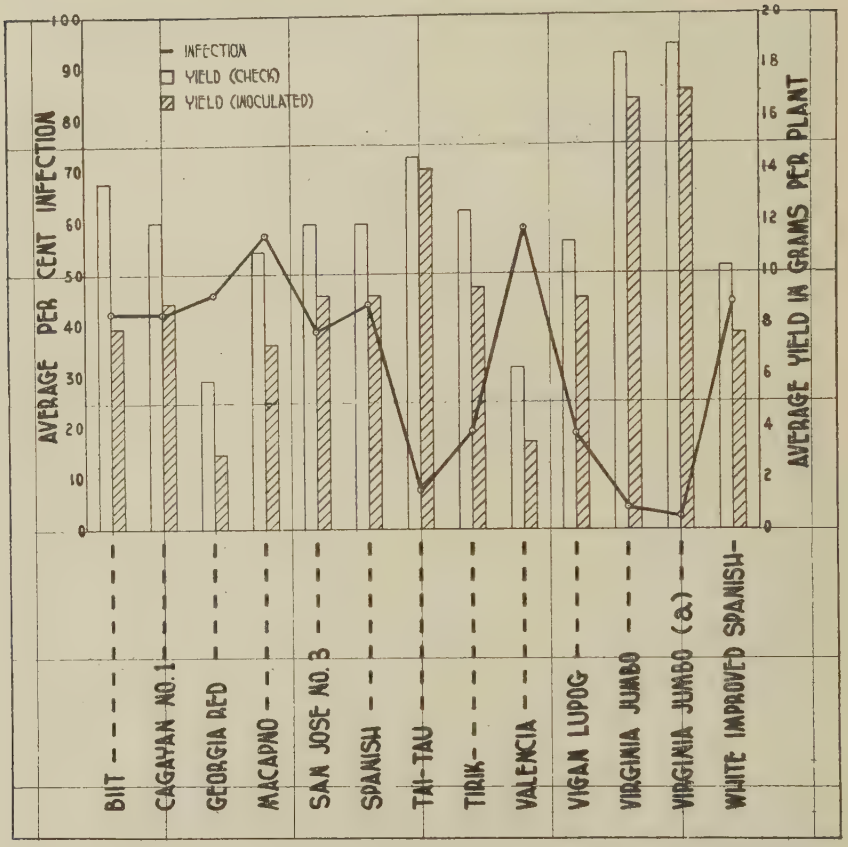


FIG. 4. Chart showing the effect of *Sclerotium rolfsii* infection on the yield, based on three years experiments.

was greater than those of the check plants (Tables 9 and 11). There was an average difference of about 36 pods in 1935, and about 94 pods in 1936. The weakening of the pegs of diseased pods seemed to be closely associated with the number of infected pods, as are also the decrease in weight of the pods, and the disintegration of their shells. A corresponding increase in the number of pods was observed in both the control and the inoculated plants during the wet season of 1936. A very wet soil, however, did not favor the development underground of *S. rolfsii* as shown by the third year's result (Table 11).

The consistent and more or less uniform results obtained in the field experiments indicate conclusively the relative resistance of the varieties of peanuts to the disease. The commercial

varieties of peanuts used, the average percentages of infection, and their relations to *Sclerotium rolfsii* are given in Table 14.

TABLE 13.—*Relative damage caused by Sclerotium rolfsii on peanut varieties as indicated by the number of diseased pods and germinated pods obtained in the 1934, 1935 and 1936 tests*

Variety	1934, 1935 and 1936			
	Average number of diseased pods		Average number of germinated pods	
	Control	Inoculated	Control	Inoculated
Biit	2.33	61.33	73.33	192.33
Cagayan No. 1	3.33	55.00	41.66	135.33
Georgia Red	3.66	74.00	10.33	143.33
Macapno	0	66.33	50.00	160.33
San José No. 3	3.00	34.66	65.00	120.66
Spanish	0	56.00	93.66	128.66
Tai-tau [a]	0	10.33	00.66	5.00
Tirik	0	27.66	119.66	197.00
Valencia	5.33	138.00	133.33	121.33
Vigan Lupog	0.66	36.33	80.33	107.33
Virginia Jumbo	0	12.33	266.00	1.33
Virginia Jumbo (a)	0	3.00	0	1.00
White Improved Spanish	2.33	52.00	101.66	113.66

[a] Two years only.

TABLE 14.—*Relative response of peanut varieties to artificial inoculation with Sclerotium rolfsii*

Classes	Proposed ratings of infection	Varieties and order of susceptibility according to percentages of infection
Very susceptible	83.31–100%	
Susceptible	66.65–83.30%	
Moderately susceptible	49.99–66.64%	Valencia, Macapno.
Resistant	33.33–49.98%	Georgia Red, White Improved Spanish, Spanish, Biit, Cagayan No. 1, San José No. 3.
Moderately resistant	16.67–33.32%	Vigan Lupog, Tirik.
Highly resistant	1.00–16.66%	Tai-tau, Virginia Jumbo, Virginia Jumbo (a).
Immune	0%	

In Table 14 it may be seen that of the varieties inoculated in the field, not a single variety was immune, although Virginia Jumbo(a) exhibited only a trace of infection. According to the proposed ratings of infection, Tai-tau, Virginia Jumbo, and Virginia Jumbo(a), are in the highly resistant class while Valencia and Macapno fall under the opposite extreme as moderately susceptible, and so on.

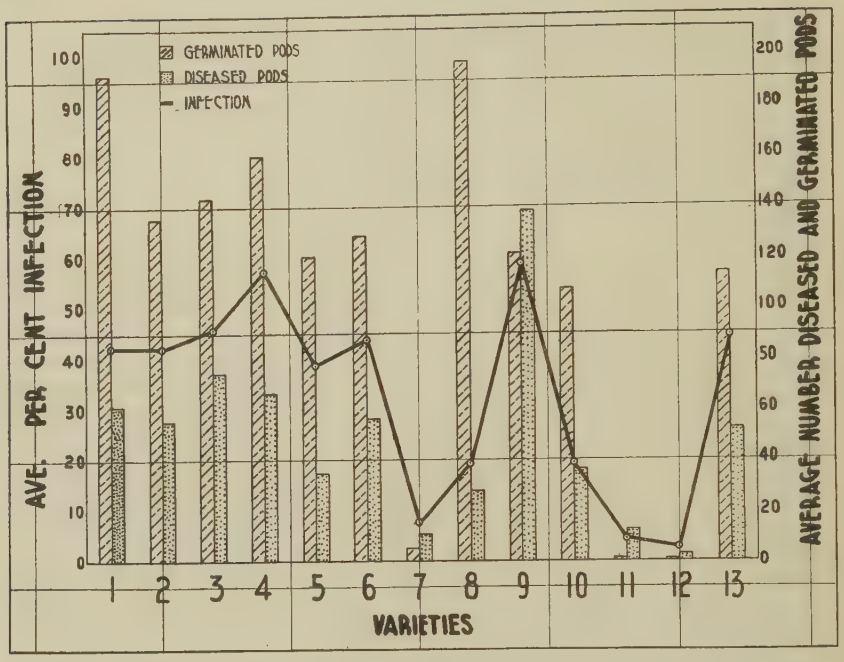


FIG. 5. Chart showing the relation of the number of infected plants to the number of diseased and germinated pods, based on three years' experiments.

DISCUSSION OF RESULTS

The Sclerotium wilt of peanut may be recognized by the wilting of the plant and the presence of lesions and mycelium on the stem. The symptoms are more pronounced under environmental conditions which promote least resistance to many plant diseases. Abundant soil moisture, high temperature and air humidity, as well as young age of plant are factors influencing the development of the disease. This influence of environment on disease was manifest by the frequent occurrence of infection in restricted areas where the plants were exposed to the same conditions. Absence of moisture has a detrimental effect upon the growth of the fungus.

The consistently uniform results in field experiments indicate conclusively the relative response of the varieties to the disease. Of the varieties inoculated in the field, not a single one was immune (Table 14), although Virginia Jumbo(a) was the most highly resistant to the disease. This variety showed only a trace of infection (Tables 6, 8 and 10). Immediately after Virginia Jumbo(a) follow Virginia Jumbo and Tai-tau. These varieties belong to the highly resistant class. Although Valen-

cia had 81.38 per cent infection in 1934 (Plate 13), the average percentage of infection was lower in subsequent years. Valencia and Macapno proved to be moderately susceptible varieties, while Tirik (Plate 14) and Vigan Lupog were moderately resistant. Georgia Red, White Improved Spanish, Spanish, Biit, Cagayan No. 1 and San José No. 3 are here classified as intermediates.

The different types of varietal response to disease development does not seem to have any relation to the habit of growth. While the prostrate varieties which are in close contact with the soil and soil organism may be expected to be more liable to infection, the erect or decumbent varieties proved less resistant to *Sclerotium* attack. Evidently the question of resistance of peanut to Sclerotium wilt has no relation to the habit of growth. Mohammad *et al.*(24) propound the idea that the spreading varieties revealed stronger capacity for disease resistance than the erect varieties. Field observations seem to indicate that relative succulence is also a determining factor for resistance (Plate 18).

It is interesting to note that despite the prostrate nature and luxuriance of vegetative growth of Virginia Jumbo (Plates 15 and 17) and Tai-tau (Plate 16), affording their runners greater chances for infection through the soil, these spreading varieties were less infected by the disease, and occasionally they were only partially (Plates 15, 16 and 17) attacked. This finding confirms the field observations of McClintock(22). Just what the nature of resistance is cannot be explained at present.

Tai-tau and Virginia Jumbo are two peanut varieties of the runner type. These varieties possess the qualities desired by farmers, dealers and consumers. Although these exotic varieties are late-maturing, they possess the rare combination of marked resistance to Sclerotium wilt together with the seed dormancy, large seeds, dark green foliage, and high yielding capacity. The value of these varieties is enhanced further by the fact that they also revealed considerable resistance to black spot infection caused by *Cercospora personata* (B. & C.) Ell. & Ev., a very common disease although of less economic importance than Sclerotium wilt.

It will be readily seen by referring to Table 13 that the resistant varieties which are generally late-maturing suffered lesser amount of damage either through infection of the fruits or through germination underground, presumably on account of thickness of the pericarp as compared with those which mature early.

There are two strains of Virginia Jumbo. One is of recent introduction, and the other, marked Virginia Jumbo(a), is a strain which has been grown for a number of years at the experiment stations of the Bureau of Plant Industry. The two plants from separate introductions react differently and in a manner somewhat consistently to *Sclerotium rolfsii* perhaps because Virginia Jumbo(a) (Plate 15) had been exposed to infection for a much longer period under Philippine conditions than the other strain; hence it may be said that it has acquired a certain degree of resistance.

Virginia Jumbo (Plate 17), a comparatively new variety in the Philippines seems to be the most resistant under field conditions when grown side by side with other varieties. It is also desirable because it is a heavy yielder on lands previously used for other crops and where other varieties grown side by side with it have failed to produce satisfactorily. The writer's results thus far show that the danger from Sclerotium wilt may still be remedied by growing resistant varieties. The results of present experiments show what varieties of peanuts to plant in *Sclerotium rolfsii*-infested soil. Virginia Jumbo and Tai-tau have invariably displayed conspicuous resistance against the ravages of this fungus.

The more or less consistent reaction of these two varieties to inoculation indicates that they carry a certain degree of inherent resistance. Working on this hypothesis, the genetic factors for breeding of varieties would seem well-nigh clear and in order. Since no variety possesses a combination of all the desirable crop factors, hybridization followed by selection would seem the best solution.

OTHER MEASURES OF CONTROL

All infected plants should be pulled out as soon as noticed. They should be destroyed by drying in the sun or by burning to prevent the propagation of the disease.

As recommended by Bertus(6) in Ceylon the soil surface of infected areas (to a depth of 8 inches or more) should be scraped off and buried in trenches or dug-outs made nearby in order to bury sclerotia that are present in the surface soil to a depth of 9 to 12 inches.

Avoid scattering diseased plants and handle them carefully because the adhering sclerotia are readily shattered.

Diseased plants should be burned *in situ* after the nuts have been harvested; then the surface soil should be forked or raked over to break the continuity of the hyphal strands. All dead leaves and decaying matter should be piled up and burned.

Close planting should be avoided, because contact of diseased and healthy plants facilitates the spread of the disease from one hill to another. Sunlight and aëration are effective checks against the progress of the fungus.

The fungus may also be spread through the soil by the migration of the fungus, by infested soils, sclerotia or diseased materials transported by water from one place to another, cultivating implements, on the feet of men and animals, and other agencies. Cattle, sheep and possibly carabaos and goats are capable of initiating new infestations, if allowed to range especially in fields where the disease is widespread and abundant.

Clean culture would help a great deal in preventing the propagation and spread of the disease as the sclerotia are formed on the stems and leaves of dead plants, and also on pods underground. By the cultivation of the soil they are distributed rather widely in partly infested fields.

Avoid using stable manure or decaying matter for fertilizer. Any decaying organic matter may facilitate the carrying over of the fungus from year to year by means of sclerotial bodies.

As a measure of starving out the organism in the soil, good agricultural practices, such as rotation with plants not subject to *Sclerotium rolfsii* attack should prove beneficial.

Liming seems to retard the progress of the fungus in the soil and thus cause a diminution of the damage; at the same time it is beneficial to peanut culture.

Careful selection of well-developed seeds free from the disease is of utmost importance for planting in soils known to be free from the disease. Although kernels may carry hyphae of the fungus it is doubtful if they could survive the period of dry storage or stocking before they are sown with the seeds. Seeds bearing fresh mycelium of the fungus may not sprout because of fungus attack. Use only cured and newly-shelled seeds because they give greater percentage of germination, and disinfection is hardly necessary.

The results of experiments reported in this paper indicate that in infested soils it would be advantageous to plant resistant varieties of peanuts in order to minimize damage. Such va-

rieties as Virginia Jumbo and Tai-tau which exhibit sufficient resistance to Sclerotium wilt should be used.

SUMMARY AND CONCLUSIONS

1. The Sclerotium wilt of peanut (*Arachis hypogæa* Linn.) appears to be one of the most destructive diseases of this crop and is found geographically distributed far and wide. The disease is important on account of growing interest in the cultivation of peanut, the introduction of new varieties for planting and the lack of systematic method of control.

2. Our information regarding this peanut wilt in the Philippines and its methods of control is still fragmentary.

3. The occurrence of Sclerotium wilt of peanut in the field may first be noted by wilting of plants and the association of the fungus, followed by the loss of the normal green color. Browning of the shanks then takes place. Soon the presence of a thick mat of white mycelium and the production of white to brown sclerotia may be noted at the base of wilted plants or on the surface of the ground. The underground parts of the plants may also be affected and these may be covered with the mycelium of the causal fungus, causing rotting of the gynophores, pods and roots.

4. The fungus is without doubt a strain of the cosmopolitan, soil-borne *Sclerotium rolfsii* Sacc. known the world over. Isolations of this fungus from peanut have proved pathogenic to the same host in artificial infection experiments. Peanuts infected while young usually die prematurely and those infected at maturity are much affected in their yielding capacity.

5. The host range of *Sclerotium rolfsii* in the Philippines is herein listed to serve as a guide to growers who practice crop rotation; they number fifty-four, seven of which are here reported for the first time. Fourteen others were produced artificially. Plants found susceptible in foreign countries and now in cultivation in the Philippines should bear close watching. The other control practices suggested should be resorted to in case the resistant varieties are not readily procurable.

6. Different varieties of peanuts grown in an infected field showed varying degrees of infection. Wilting ranging from 31.3 to 50.7 per cent of the plants was noted by actual counts.

7. Varieties used in field inoculation tests showed susceptibility to peanut wilt in the descending order as follows: (*a*) Va-

lencia; (*b*) Macapno; (*c*) Georgia Red; (*d*) White Improved Spanish; (*e*) Spanish; (*f*) Biit; (*g*) Cagayan No. 1; (*h*) San José No. 3; (*i*) Vigan Lupog; (*j*) Tirik; (*k*) Tai-tau; (*l*) Virginia Jumbo; and (*m*) Virginia Jumbo(a). The least infected varieties were, Virginia Jumbo(a), Virginia Jumbo, and Tai-tau while Valencia and Macapno were the most seriously infected.

8. Although the yearly results are not very consistent, the summarized results show a close and definite relation of the number of diseased pods to infection, and to a lesser degree also, the number of germinated pods.

9. As is to be expected infection is more severe during the wet season than during the dry period of the year.

10. Virginia Jumbo(a), Virginia Jumbo and Tai-tau are late-maturing varieties but they are heavy yielders. They produce large kernels with good dormancy quality. Most important of all, they are disease resistant.

11. The results of three years' experiments have shown that among peanuts the runner types are more resistant to Sclerotium wilt than the erect or semierect varieties. Subsequently the question of resistance to this disease of peanut hybrids possessing a combination of the resistant quality of one variety and the desirable agronomic characters of another will be a feasible objective. A histopathological study and inquiries leading to the nature of resistance may be undertaken later to follow the mode of destruction of the host cells in some detail and also to determine definitely what features are responsible for resistance.

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ILLUSTRATIONS*

PLATE 1

A hill of Valencia variety which completely succumbed to infection with *Sclerotium rolfsii* Sacc., showing the prostrate condition of the plant and accumulations of white and brown sclerotia at the base.

PLATE 2

Pods obtained from two plants of Valencia showing underground infection, and shrunken shoots from germinated pods. Note the profuse growth of white mycelium on the surface and presence of the fungus on the stems of the wilted seedlings. x 0.8.

PLATE 3

Peanut pods from a severely infected plant, Valencia variety, showing copious growth of the cottony mycelium of *Sclerotium rolfsii*, rendering all the pods unmarketable. x 1.

PLATE 4

Five-day old cultures of *Sclerotium rolfsii* Sacc. on cut leaves of dapdap, *Erythrina variegata* Linn. var. *orientalis* (Linn.) Merr. (*Erythrina indica* Lam.) showing typical fan-shaped, coarse, white feathery vegetative growth; about ⅔ natural size.

PLATE 5

Fifteen-day old culture of *Sclerotium rolfsii* on chopped dapdap leaves sterilized in autoclave, to show formation of brown sclerotial bodies; natural size.

PLATE 6

FIG. 1. Inoculated peanut plants showing the first stages of the disease at the right and the control plants at the left.

2. A more advanced stage of the disease resulting from artificial infection at the left pot and the check pot at the right.

PLATE 7

Partial view of the experimental field, showing a few of the control plats taken 70 days after the date of planting. Photographed October 31, 1935.

PLATE 8

A plat of Georgia Red variety inoculated with *Sclerotium rolfsii* Sacc., showing moderate susceptibility as evidence by the wilted and partly dying plants which can be seen only by a careful scrutiny.

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* Sixteen of the photographs used in this paper were taken from the writer's specimens by the Bureau of Science, and six by the Division of Publications, Department of Agriculture and Commerce, Manila, P. I.

PLATE 9

Control plat of Georgia Red variety photographed on the same day as the inoculated plat shown in Plate 8, exhibiting absolute freedom from the disease.

PLATE 10

Another plat of peanut, variety San José No. 3, showing great susceptibility produced by artificial infection. Note the thinness of growth on account of infection due to *Sclerotium rolfsii.* Compare with the healthy control plat in Plate 11.

PLATE 11

Control plat of the variety San José No. 3 which is completely free from infection.

PLATE 12

This picture shows a partial view of the experimental field. In the foreground is a plat of Valencia variety showing varying stages of infection as a result of artificial inoculation with *Sclerotium rolfsii.*

PLATE 13

A plat of Valencia under test for resistence to *Sclerotium rolfsii,* which proved the most susceptible variety. Note that nearly all the plants have been killed by the disease except a few in the background.

PLATE 14

An inoculated plat of peanut, Tirik variety, showing considerable resistance to Sclerotium wilt. Note the plant pointed by arrow which shows slight infection where only a portion of the individual plant is diseased.

PLATE 15

A plat of Virginia Jumbo (a), an exotic variety of the runner type tested for resistance to *Sclerotium rolfsii,* which proved to be very little, if at all, affected by it.

PLATE 16

A plat of a tolerant peanut variety Tai-Tau, having growth characteristics very similar to Virginia Jumbo, photographed 26 days after inoculation. Note also the infections in the neighboring variety at the right which is partly visible.

PLAT 17

A plat of an exotic peanut variety, Virginia Jumbo, that has consistently shown considerable resistance to *Sclerotium rolfsii.* Photographed 26 days after inoculation.

PLATE 18

An infected stem of Georgia Red (left), showing severe wilting compared with that of Virginia Jumbo (right), exhibiting no apparent sign of wilting effect in spite of the presence of the inoculum at the base of the stem. Both plants got infected at the same time.

PLATE 19

Three stems of Virginia Jumbo (left), inoculated with *Sclerotium rolfsii* Sacc., showing scarcity of growth of the fungus even under extremely favorable weather and soil conditions, compared with the luxuriance of mycelial growth on the stems of a susceptible variety, Georgia Red. Inoculated simultaneously and later photographed on same date. Approximately x 1–1/20.

PLATE 20

Two split stems of a resistant variety, Virginia Jumbo (left), showing very slight evidence of internal invasion or appreciable injury as a result of inoculation. The white stuff in the hollow of the stems is the pith. Compare with a diseased stem of susceptible Georgia Red at the right. Note the discoloration at the seats of infection, pointed by arrows, the inner tissues having been partly consumed by the inoculum. Approximately x 1–3/20.

PLATE 21

Diseased pods (first two upper rows) of Georgia Red variety dug up with the inoculated plants at time of harvest, showing infection of pods which took place underground. Note the development of sclerotial bodies on the surface of the pods and presence of abundant white mycelia inside the opened pods as compared with the healthy pods in the third row. Approximately x 1.08.

PLATE 22

Pods of Valencia variety (two rows at top) infected with *Sclerotium rolfsii*, showing its destructive effects as evidenced by the presence of mycelia and white to brown sclerotia of the inoculum compared with the healthy pods at the bottom. x 1.

TEXT FIGURES

FIG. 1. Plan of the experimental field, showing the arrangement of plats, distribution of the varieties, and distancing.

2. Representing graphically the effect of artificial inoculation on the yield for the three-year period.
3. Chart showing by year the effect of inoculation on the pods underground.
4. Chart showing the effect of *Sclerotium rolfsii* infection on the yield, based on three years' experiments.
5. Chart showing the relation of the number of infected plants to the number of diseased and germinated pods, based on three years' experiments.

PLATE 1.

PLATE 2.

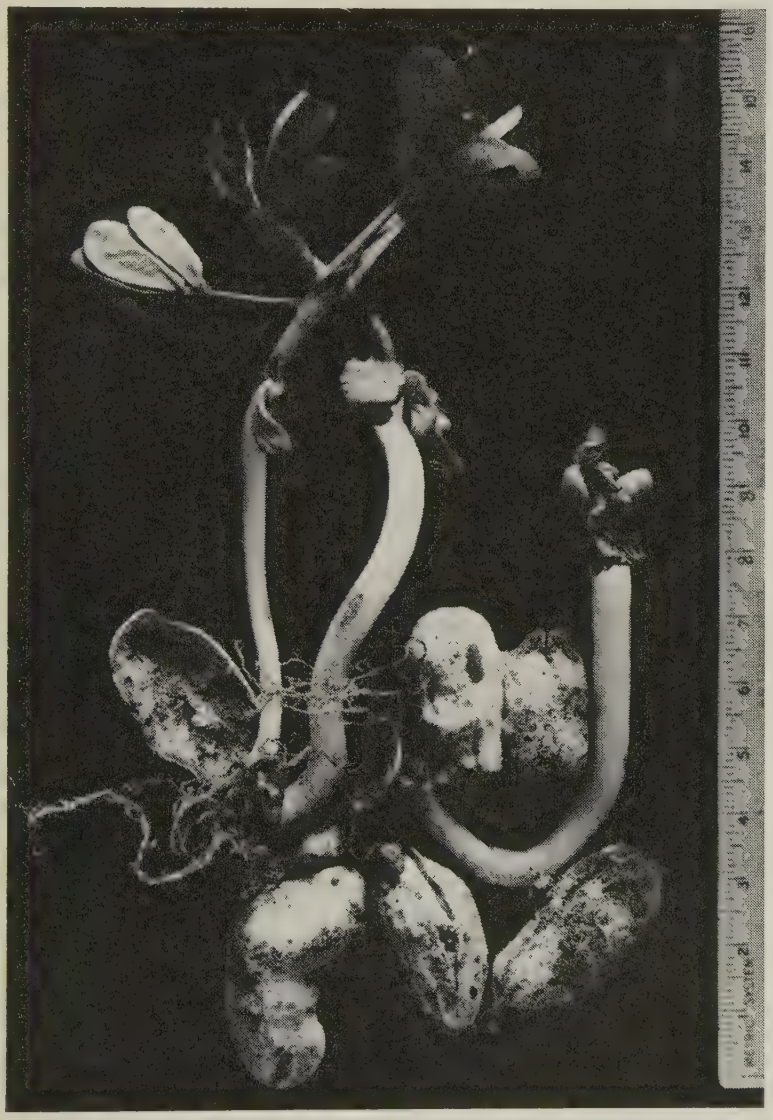

PLATE 3.

PLATE 4

PLATE 5.

1

2

PLATE 6.

PLATE 7.

PLATE 8.

PLATE 9.

PLATE 10.

PLATE 11.

PLATE 12.

PLATE 13.

PLATE 14.

PLATE 15.

PLATE 16.

PLATE 17.

PLATE 18.

PLATE 19.

PLATE 20.

PLATE 21.

PLATE 22.

THE MELON FLY (*DACUS CUCURBITÆ* COQUILLET)

By Andrés Ponce

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Bureau of Plant Industry

FOUR PLATES AND TWO TEXT FIGURES

INTRODUCTION

Cucurbits are important and popular vegetables among the Filipinos because they can be easily grown in the backyard and the fruits are easily sold or marketed. The growing of patola, amargoso, upo, squash, cucumber, condol, and the like, either for market or for home consumption is being done in almost every home in our rural districts. A study of the insects destructive to these plants, of which melon fly is one of the most common, is therefore important.

It is the aim of this paper to emphasize to the vegetable growers the economic destruction done by the melon fly as one of the major pests of cucurbitaceous plants and to present some means of minimizing its damage. The data herein reported were obtained during 1932, 1935, and the first semester of 1936 in the Entomology Laboratory of the Bureau of Plant Industry, Manila.

SYSTEMATIC POSITION

The melon fly was included under Dacinæ, a subfamily of Trypetidæ by Back and Pemberton (1917), Trypaneidæ by Bezzi (1919), and Trupaneidæ by Curran (1934). The synonyms of the species are as follows:

Bactrocera cucurbitæ Coq. (Back and Pemberton). (1917).
Chætodacus cucurbitæ Coq. (Bezzi). (1919).
Dacus cucurbitæ Coq. (by most authors).

REVIEW OF LITERATURE

Essig (1913) gave credit to C. F. Baker as the authority of the information that *Dacus cucurbitæ* Coq. is abundant in the Philippines. Tuason (1917) estimated its destruction on cucurbits from 30 to 40 per cent. Bezzi (1919) described specimens collected also by Baker from Makiling, Los Baños, Prov-

ince of Laguna, and in the province of Davao. Woodworth (1912) reported 17 host plants in the Islands. In the Philippines the life history of the melon fly has not been adequately studied.

Froggatt (1909) found that the melon fly thrives in India and Ceylon on melons, cucumbers, bitter gourds, and eggplants. He found out that the flies are not attracted to citronella oil. Fletcher (1917) stated that the melon fly is a serious pest of cucurbits and widely distributed throughout India and Burma. Muir (1914) cited *Dacus cucurbitæ* Coq. as being common and harmful to cucumbers and melons in Formosa. Hill (1915) listed *Dacus cucurbitæ* Coq. as a pest of melon, pumpkin, and marrow squash in Northern Australia.

In Hawaii Back and Pemberton (1917) and (1918) made a more or less complete study of the biology of this insect and conducted some experiments on its control.

ORIGIN AND DISTRIBUTION

Back and Pemberton claimed that the original home of the melon fly is the Indo-Malayan region. It is present in India, Ceylon, Java, Timor, Australia, Southern China, Singapore, Japan, Hawaii, Hongkong, and the Philippines.

The species may have been introduced into the Philippines from India, its original home, or from Japan and China through imported cucurbit fruits before there was any plant quarantine.

ECONOMIC IMPORTANCE

The melon fly is one of the destructive pests on cultivated species of cucurbits. In Hawaii the melon fly attacks the roots, stems, foliage, blooms, and fruits of cucurbits and other vegetables so that the raising of these crops as an industry has been seriously hampered. In the Philippines the injuries of the melon fly appear to be confined only to the fruits of the host plants. Nevertheless, these damages reach serious proportions.

MANNER OF INJURY

The adult female fly lays eggs by inserting them inside the fruits through wounds on the skin caused by its ovipositor. As soon as the eggs hatch, the maggots destroy and convert the inside pulp of the fruits into a semi-liquid mass. On young fruits, infestation very often results into suppressed growth and deformities which render them entirely useless (Plate 3, figs. 2, 3). Instances were observed in which adult flies infested sound

fruits of amargoso, cucumber, and patola left exposed in the market, so that those fruits after two or three days became useless due to the presence of maggots inside.

HOST PLANTS

The writer observed the pest in nine host plants, the "amargoso" and "patola" being the most susceptible, as follows:

1. Amargoso (*Momordica charantia*).
2. Cucumber (*Cucumis sativus*).
3. Melon (*Cucumis melo*).
4. Patola (*Luffa cylindrica*).
5. Squash (*Cucurbita maxima*).
6. Upo (*Lagenaria leucantha*).
7. Water melon (*Citrullus vulgaris*).
8. Eggplant (*Solanum melongena*).
9. Tomato (*Lycopersicum esculentum*).

In the host index prepared by Woodworth (1921) 17 host plants of the melon fly were recorded, which includes the following beside those listed above:

1. Passion flower (*Passiflora* sp.).
2. Cowpea (*Vigna sinensis*).
3. Papaya (*Carica papaya*).
4. Guayabano (*Annona muricata*).
5. Ates (*Annona squamosa*).
6. Custard apple (*Annona reticulata*).
7. Mango (*Mangifera indica*).
8. Guava (*Psidium guajava*).

LIFE HISTORY AND HABITS

METHODS OF STUDY

In rearing the melon fly, battery jars, 16.5 by 20.5 centimeters provided with cheese cloth covers, were used. Food was supplied to the flies in the jar using the method described by Peterson (1934) in rearing blow flies, which consists of water slightly sweetened with brown sugar placed in an inverted beaker or vial on small Petri dish or syracuse watchglass, provided with filter paper or blotting paper at the bottom (Plate 2). This way of feeding prevented the flies from getting entangled or getting stuck to the food and at the same time furnished the flies with a constant supply of food from 5 to 6 days. The insects were also provided with sliced or whole fruit of the host for oviposition. Slight injuries were made in the skin of the fruit to facilitate the laying of the eggs.

DESCRIPTIONS

The Adult.—Bezzi (1919) distinguished the adult melon fly from other species of fruit flies in the Philippines by the three pairs of lower orbital bristles, the middle yellow stripe of the back of the mesonotum, and the peculiar wing pattern with broadly infuscated hind crossvein. The length is usually not over 6 to 6.5 millimeters (Plate 1, fig. 5). Froggatt (1909) gave the following original description of Coquillet to which my specimens conformed:

> Head, light yellow, the occiput, except the sides and upper margin, reddish yellow, and ocellar black dot, front marked with brown spot in front of its center and with three pairs of orbital brown dots, a black spot on each side of the face near the middle, and a brown spot on the middle of each cheek; antennæ, palpi, and proboscis yellow, the latter mottled with brown; thorax, reddish-yellow, the humeri, median vitta on the posterior half of the mesonotum, another on each side, above the insertion of the wings, uniting with an irregular band which extends upon the pleura to the upper part of the sternopleura, also a large spot on each side of the metanotum, encroaching upon the hypopleura, light yellow; scutellum, except its extreme base, light yellow, bearing two bristles; abdomen light yellow on first two segments, reddish-yellow on the others, the extreme base, a facia at the bases of the second and third segments, usually a lateral spot on the fourth and fifth, also a dorsal vitta on the last three segments, blackish or brownish; first segment of the ovipositor of the female slightly longer than the fifth segment of the abdomen. Wings hyaline, the apex of the subcostal cell, from a short distance in front of the apex of the auxilliary vein, the marginal and submarginal cells, the median third of the first basal cell, and a large spot in upper outer corner of the first posterior cell, brown, this colour encroaching on the third posterior cell and bordering the sixth vein almost to its apex; posterior crossvein bordered with brown, this colour extending to the hind margin of the wing; upper end of the small crossvein is also bordered with brown. Halteres light yellow. Legs light yellow, the broad apices of the femora and the last four joints of the tarsi reddish-yellow; hind tibiæ reddish-yellow or dark brown.

THE EGG

The egg of the melon fly is glistening white and is about 1.4 to 1.7 millimeters long and 0.25 millimeter wide. It is ellipsoidal and slightly curved. The eggs are deposited in the slightly injured rind of the host fruits usually to a depth of 4 to 9 millimeters (Plate 1, figs. 1 and 2).

THE LARVA

The maggot of the melon fly passes through three stadia or instars. The external structures of every stadium are as follows:

First instar.—Size, about 2 by 0.08 millimeters; head pointed; provided with very tiny mouth hooks or mandibles; without anterior spiracles but minute posterior spiracles present with two tiny slits on each stigmal plate surrounded by three groups of fine hairs or bristles.

Second instar.—Size, about 4 by 1.4 millimeters; mouth hooks or mandibles about two times the first instar. Anterior spiracles with 18 lobes, divided into two arcs which are fan-shaped and located at the hind edge of the second segment. Posterior spiracles consist of three slits with four sets of fine hairs on each stigmal plate.

Third instar.—The full grown larva is about 10 by 2.5 millimeters and it has 12 segments. Head slightly bilobed and pointed at the anterior apex with two antennal protuberances. In the center of the lobe are developed black mouth hooks or mandibles which are about twice as much as the second instar. Anterior spiracles large, about two times that of the former instar and have the same number of lobes but more uniform in a single arc. The posterior segment is more or less flat and bears the posterior spiracles which are very well developed and somewhat more elevated than those of the second stage or instar. There are four sets of longer hairs than the preceding instar and two more or less protuberances above the stigmal plates. The anus is located below the stigmal plates and between the pair of more or less connected tubercles of the ventro-caudal surface of the last segment. In almost every segment spinulose area with scattered hooklets are present on the ventral side (Plate 1, fig. 3).

THE PUPA

The puparium is 5.5 millimeters; elliptical and has 12 visible segments; generally dark testaceous. The apex of the first segment shows indication of the larval mouth hooks or mandibles and on both sides are the anterior spiracles with their lobes. A short black line is located on the last segment between the posterior spiracles and the anal opening, which is transformed into a small black spot. Spinulose areas are shown on the ventral side in almost every segment as two narrow bands but do not extend to the lateral sides of each segment (Plate 1, fig. 4).

LENGTH OF LIFE CYCLE

Incubation period.—In this work the eggs were found to hatch within a minimum period of 0.5 day, a maximum of

4 days and an average period of 1.73 days as shown in Table 2. No change in color was observed on the eggs from the time they were laid up to the time when they hatched.

Larval period.—The maggots after coming out from the eggshells begin making tunnels and destroying the inside content of the fruits and sometimes including the seeds (Plates 3 and 4, fig. 1). Full grown maggots are generally white but very often the color changes to greenish yellow depending upon the kind of the host fruit. For instance the maggots feeding on amargoso and patola are darker than those feeding on cucumber. If disturbed the maggots can leap a few centimeters high. Maggots leave the infested fruit through an exit hole made by them and then drop to the ground wherein they pupate (Plate 4, fig. 2).

Table 3 shows the average duration of the larval instars of 60 cultures on five different hosts. The first stadium lasted for 1.38 days; the second, 2.27 days; and the third or last, 2.87 days. The length of the larval period was 5 days, when reared in papaya fruit, which was the shortest among the group at a mean temperature of 29.15° C. In "upo" the length of the larval period was 6 days at 30.36° C. Rearing the melon fly in patola and amargoso, the most favored hosts, gave almost the same length of larval period which were 6.49 and 6.50 days at the mean temperatures of 30.34° C. and 30.36° C., respectively.

The average length of the larval period as given in Table 3 was 6.12 days as compared with 6.06 days in Table 2. The slight difference may be due to the slight disturbances under which the maggots were subjected during the observations, and may be attributed to the effects of different host fruits. The minimum length of larval period as given in Table 2 was 4 days and the maximum being 6 days.

Pupal period.—The full-grown maggots in order to pupate left the infested fruits (Plate 4, fig. 1), dropped to the soil, and went down to a depth of 7 to 15 centimeters. In cases where the surface soil was very hard it was observed that pupation took place just beneath any object laying on the ground. The pupation was accomplished for about 50 minutes (Plate 1, fig. 4).

The pupal period ranges from 7 to 11 days with an average period of 8.59 days (Table 2).

From egg laying to emergence.—The length of time from egg laying to emergence of the adult flies in 32 cultures is shown in Table 2. The minimum number of days was 12.5; the maximum, 21 days; and the average, 16.5 days.

OBSERVATIONS ON THE ADULT FLIES

Emergence.—The emergence of the adult flies usually occurred from early in the morning up to about 10 o'clock. The process was by breaking the wall at the anterior end of the puparium with the aid of the ptilinum forcing its way out of the soil. Newly emerged adults were pale in color with wings still folded. After about 30 minutes the wings were fully expanded and the entire body hardened.

Sex ratio.—In order to determine the corresponding number of males and females, counts were made on the emerging adult flies from infested fruits collected in the field. The ratio is shown in Table 4. From 30 cultures the average was 22.3 males and 24.5 females or a ratio of 0.4765 to 0.5237. The ratio is almost equal.

Mating.—Mating usually occurred from 6 in the afternoon to 6 in the following morning, and in some cases up to about 9 a. m. The process was accomplished by the male embracing the abdomen of the female and the head of the male touching the scutellum of the female. It was observed that the pair was able to wander while in copula and often one female was fertilized by several males.

Oviposition.—The pre-oviposition period was observed on 20 adult female flies as shown in Table 5. The minimum period was 7 days with a maximum of 26 days, the average being 15.9 days. Oviposition usually lasted from 0.4 to 2.2 minutes with an average of 1.1 minutes.

A female fly which is about to lay her eggs wanders around the surface of the host fruit looking for suitable spot. Upon locating she begins laying her eggs by first extending her ovipositor in full length and then bends it forward to form an almost acute angle with the axis of the abdomen. Then it inserts her ovipositor deep into the fruit by an up and down motion until the desired depth is attained.

The duration of egg laying or period of fecundity was also determined with the same flies. The minimum was 39 days and the maximum 95 days, with an average of 53.6 days (Table 5).

Rate of oviposition.—Observations on the rate of oviposition were made on 10 adult female flies which were carefully reared in battery jars supplied daily with fresh food (sugar solution) and fruits of "patola" and "amargoso." As shown in Table 6, the highest number of eggs was laid by No. 9 being 494, next

was female No. 4 with 461 eggs, and then followed by female No. 10 with 420 eggs. The least number was laid by No. 2 which was 114. Flies Nos. 6 and 8 escaped accidentally, so the data on them are incomplete.

The daily rate of oviposition was also obtained. It will be noted that the melon flies were able to lay eggs almost daily at times and then with greater intervals at other times. The greatest number of eggs laid per day was recorded on the first laying day of fly No. 6, being 45 eggs. The next highest was laid by the tenth laying of fly No. 9 and this was 43 eggs. This was followed by the 4th and 25th laying of fly No. 4 amounting to 40 eggs. The least number laid by the flies was 1 to 2 eggs

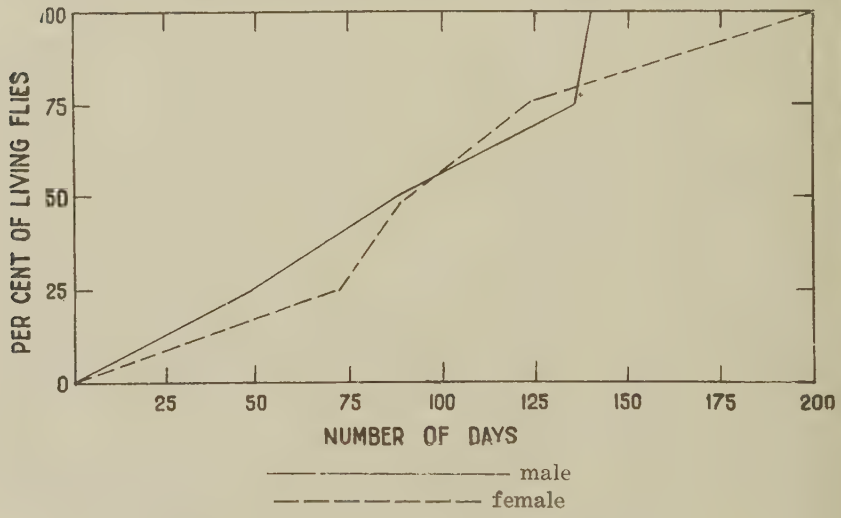

CHART 1.—Longevity of male and female in mass culture.

per day. The average daily rate of oviposition recorded for flies Nos. 1 to 10 were 12, 8, 12, 14, 13, 19, 27, 9, 18, and 16, respectively. The highest oviposition average was made by fly No. 7 and the least was by fly No. 2.

Longevity of adult males and females.—Back and Pemberton (1917) observed a female melon fly to have lived for 431 days in Hawaii when kept well supplied with food. Under insectary conditions at the Central Experiment Station, Manila, adult flies lived in a much shorter time. The longevity of adult male and female flies was taken from individual cultures (Table 7). In general, the length of the life of adults was very irregular, ranging from 30 to 90 days for the males and 36 to 143 days for the females. It will be seen that the female melon flies lived longer than the males as shown by their averages, which

are 70.9 days for females and 60.8 days for males. This was true also on mass cultures of males and females as shown in Chart 1.

CONTROL MEASURES SUGGESTED

1. Collecting and destroying infested fruits.—This is a practical method of reducing the damage by this pest, since every infested fruit destroyed means a proportionate decrease of melon fly population capable of infesting other fruits. Infested fruits collected may be destroyed either by burning or burying them for not less than a meter deep in the soil, or by carefully placing them in an empty tin can or barrel properly covered and with kerosene or a strong solution of lime for at least 3 days. Throwing the collected infested fruits into pits is not advisable because the mature maggots will have the chance to pupate in the soil and develop into adults.

2. Bagging the fruits.—This method is a means of protecting the fruits from future infestation by preventing the female flies from ovipositing in them. The material that may be used are Manila paper, newspapers, worn out clothes, etc. Obviously, the newspaper is the most economical to use. It was, however, observed that the female flies were able to oviposit in fruits when the bags were placed in contact with them so it is best to employ this method during the dry season.

The practice of bagging the fruits may be profitably employed by small growers, especially in their back yards. In the growing of cucurbits on a large scale, bagging the fruits requires a large amount of materials; besides, the work is rather tiresome, but even then it would pay to take the trouble to save the crop, especially where labor is cheap.

CHEMICALS TESTED

Laboratory experiments with poisoned baits were conducted and the following formulæ were used:

1. Copper sulphate	1 gram
Brown sugar	25 grams
Water	1 liter
2. Lead arsenate	2 grams
Brown sugar	20 grams
Water	1 liter
3. Calcium arsenate	3 grams
Brown sugar	20 grams
Water	1 liter
4. White arsenic	1 gram
Brown sugar	15 grams
Water	1 liter

5. Sodium arsenite	2 grams
Brown sugar	15 grams
Water	1 liter

The first formula was adapted from Darby and Kapp (1934) and the second formula from Miller and McBride (1931) with some slight modifications, while the last three are original. Each test was conducted in triplicate, 25 flies being used in each trial. The baits given above were introduced to the melon fly culture in the battery jar by spraying the solution on the inner side wall of the jar and by wetting a piece of cotton with the poison solution and placed inside the jar. Chart 2 and Table 1 show the result of the experiments.

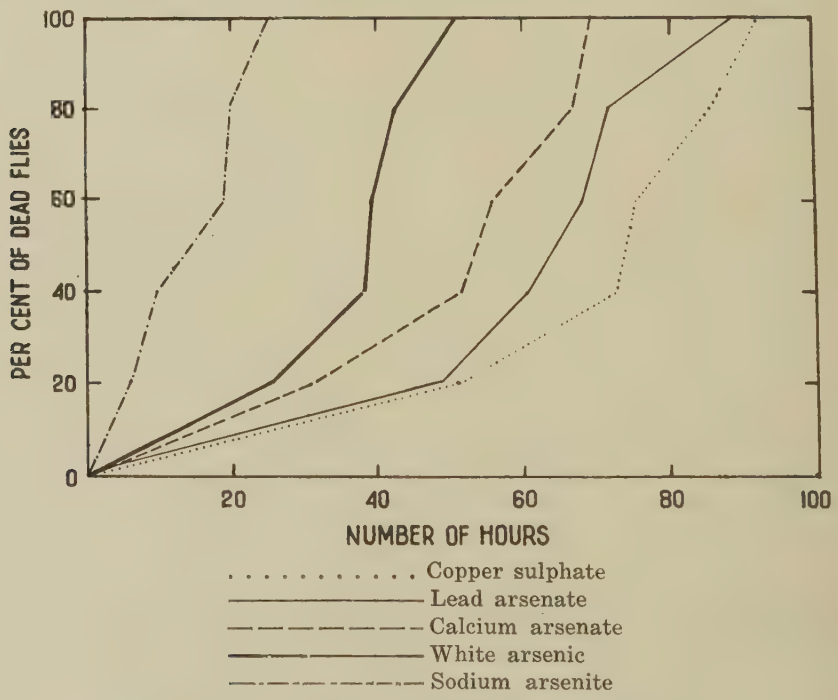

CHART 2.—The toxicity of five insecticides on melon flies.

Among the insecticides used, sodium arsenite gave the most promising results with white arsenic next. With sodium arsenite there was registered 20 per cent mortality after 6 hours, 40 per cent after 10 hours, 60 per cent after 19 hours, 80 per cent after 20 hours, and 100 per cent mortality after 29 hours. With white arsenic 20 per cent of the flies died after 26 hours, 40 per cent after 38 hours, 80 per cent after 44 hours, and 100 per cent died after 53 hours. The calcium arsenate treatment

showed a mortality of 20 per cent after 32 hours, 40 per cent after 52 hours, 60 per cent after 55 hours, 80 per cent after 67 hours, and 100 per cent after 68 hours. With the first two formulæ the effect was quite slow as all flies died after 88 hours and 92 hours, respectively. Field tests are necessary in order to ascertain the practicability of using poisoned baits under field conditions—at least those found most effective in the laboratory.

NATURAL ENEMIES

In the course of this study only one species of parasites was reared several times on infested fruits of "amargoso" and "patola" collected from the field. The percentage of parasitism as observed in this work appears to be low. According to F. Q. Otanes of the Plant Pest and Disease Control Division of this bureau, the parasite apparently agrees with the descriptions of *Opius fletcheri* Silvestri,[1] a braconid, alive specimens of which were introduced by him into the Philippines from Hawaii in 1923. Mr. Otanes stated, however, that the identity of the parasites needs to be verified by sending specimens to authorities in Hawaii or in India.

SUMMARY AND CONCLUSIONS

1. Cucurbits belong to an important group of vegetables in the Philippines, so the study of their most harmful pests is important.

2. The melon fly is one of the major pests of cucurbits here and in other countries. The synonymy of the species is as follows:

Bactrocera cucurbitæ Coq. (Back and Pemberton).
Chætodacus cucurbitæ Coq. (Bezzi).
Dacus cucurbitæ Coq. (by most authors).

3. The original home of the melon fly is the Indo-Malayan region and this species was probably introduced long ago into the Philippines from India, China, or Japan through commerce before there was any plant quarantine work in the Philippines.

4. In the Islands the melon fly confines its attacks on the fruits of the host plants and the infested fruits become useless for the market.

5. There are 17 host plants under 7 families but only 9 of them were encountered in the present study.

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[1] The alive specimens were furnished to Mr. F. Q. Otanes by Mr. D. T. Fullaway, an entomologist, in Hawaii.

6. Incubation period, 0.5 to 4 days with an average of 1.73 days; three larval instars, first stadium, 1.38 days, second stadium, 2.27 days, and the last stadium 2.87 days; larval period 6.12 days; pupal period 7 to 11 days with an average of 8.59 days; from egg to emergence 12.5 to 21 days with an average of 16.5 days.

7. The emergence of adult flies occurred from early to about 10 o'clock in the morning; the proportion of sexes from 30 cultures was 22.3 males to 24.5 females; mating usually occurred from 6 o'clock in the afternoon to 6 o'clock in the morning; pre-oviposition period, 7 to 26 days with an average of 15.9 days; oviposition lasted from 0.4 to 2.2 minutes.

8. The highest number of eggs daily laid by a female was 45 and the lowest was one and the total number of eggs laid individually ranged from 114 to 494.

9. The length of life of the female flies was from 36 to 143 days, the average being 70.9; that of the male ranged from 30 to 90 days and the average was 60.8.

10. The practical methods of reducing the damages of the melon fly are by collecting and destroying the infested fruits, and by bagging the fruits from the time they begin to form.

11. Baits were tried in the laboratory with copper sulphate, lead arsenate, calcium arsenate, white arsenic and sodium arsenite as the toxic agents. The white arsenic and sodium arsenite were found more toxic to the flies than the copper sulphate, lead arsenate, and calcium arsenate.

ACKNOWLEDGMENT

The writer gratefully acknowledges the encouragement and useful suggestions given by Dr. Gonzalo Merino and Mr. Faustino Q. Otanes, Chief, and Assistant Chief, Plant Pest and Disease Control Division of this bureau, respectively, during the progress of this work. His thanks are also due to Mr. Santiago R. Capco for his help in the preparation of the manuscript.

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TABLE 1.—*Showing the effect of some insecticides on adult melon flies*

Insecticides	Sugar	Water	Number of hours the flies died				
			20 per cent	40 per cent	60 per cent	80 per cent	100 per cent
	Grams	*Liter*					
Copper sulphate 1 gram	25	1	52	73	76	86	92
Lead arsenate 2 grams	20	1	49	61	68	73	88
Calcium arsenate 3 grams	20	1	32	52	55	67	68
White arsenic 1 gram	15	1	26	38	39	44	53
Sodium arsenite 2 grams	15	1	6	10	19	20	29

TABLE 2.—*Life history*

Culture number	Incubation period	Larval period	Pupal period	Length of time from egg to emergence
	Days	*Days*	*Days*	*Days*
1	1.0	6	7	14.0
2	3.0	9	7	20.0
3	3.0	6	7	16.0
4	4.0	7	8	19.0
5	3.0	4	10	17.0
6	0.5	7	9	16.5
7	1.0	8	8	17.0
8	0.5	7	9	16.5
9	0.5	7	9	16.5
10	1.0	7	11	19.0
11	2.0	6	9	17.0
12	1.0	7	10	18.0
13	2.0	4	11	17.0
14	3.0	8	7	18.0
15	3.0	7	9	19.0
16	0.5	5	7	12.5
17	3.0	5	7	15.0
18	4.0	7	8	19.0
19	0.5	5	8	13.5
20	4.0	6	8	18.0
21	0.5	6	9	15.5
22	1.0	6	9	16.0
23	1.0	6	9	16.0
24	1.0	6	10	17.0
25	1.0	5	7	13.0
26	2.0	5	7	14.0
27	1.0	4	11	16.0
28	1.0	7	9	17.0
29	2.0	8	11	21.0
30	1.0	5	9	15.0
31	0.5	7	7	14.5
32	3.0	5	7	15.0
Minimum	0.5	4	7	12.5
Maximum	4.0	9	11	21.0
Average	1.73	6.06	8.59	16.5

TABLE 3.—*Average duration of larval stadia or instars*

Host	Date	Mean temperature	Number of cultures	Stadia in days			Larval period
				First	Second	Third	
		°C.					*Days*
Patola (*Luffa cylindrica*)	III–7 to IV–16–35	30.34	31	1.09	2.61	2.79	6.49
Amargoso (*Momordica charantia*).	III–18 to IV–11–35	30.36	14	1.18	2.39	2.95	6.50
Squash (*Cucurbita maxima*)	IV–2 to 11–35	29.07	6	1.00	2.83	2.83	6.66
Upo (*Lagenaria leucantha*)	III–18 to IV–1–35	30.36	6	0.92	1.84	3.25	6.00
Papaya (*Carica papaya*)	IV–2 to 7–35	29.15	3	1.00	1.67	2.33	5.00
Average		29.85		1.38	2.27	2.87	6.12

TABLE 4.—*Proportion of sexes of emerging adult melon flies*

Culture number	Date of emergence	Number of males	Number of females
1	9-II-35	17	19
2	20-II-35	46	40
3	21-II-35	46	35
4	22-II-35	11	14
5	23-II-35	11	23
6	24-II-35	5	3
7	28-II-35	48	67
8	15-III-35	11	13
9	18-III-35	6	13
10	20-III-35	27	26
11	24-III-35	26	17
12	26-III-35	5	12
13	28-III-35	22	22
14	28-III-35	70	75
15	29-III-35	50	28
16	20-IV-35	12	19
17	23-IV-35	20	28
18	29-IV-35	29	20
19	24-V-35	12	12
20	2-IX-35	50	42
21	22-X-35	12	15
22	23-X-35	23	39
23	23-X-35	18	26
24	25-X-35	32	53
25	5-XI-35	20	20
26	18-XI-35	4	10
27	19-XI-35	10	10
28	10-XII-35	11	9
29	23-XII-35	5	6
30	28-XII-35	9	19
Average		22.3	24.5
Sex ratio		0.4765	0.5237

TABLE 5.—*Pre-oviposition period and fecundity of female adult melon fly*

Culture number	Pre-oviposition period			Period of fecundity	
	Emerged	Eggs laid	Days	Last laying	Days
1	22-VII-32	11-VIII-32	20	3-X-32	53
2	22-VII-32	2-VIII-32	11	7-X-32	66
3	22-VII-32	9-VIII-32	18	16-X-32	68
4	23-VIII-32	1-VIII-32	9	9-XI-32	95
5	1-VIII-32	12-VIII-32	11	5-X-32	54
6	6-VIII-32	17-VIII-32	11	13-X-32	57
7	22-VIII-32	29-IX-32	7	9-X-32	41
8	23-VIII-32	5-IX-32	13	21-X-32	46
9	11-X-35	24-X-35	13	2-XII-35	39
10	22-X-35	5-XI-35	14	21-XII-35	46
11	23-X-35	7-XI-35	15	27-XII-35	50
12	23-X-35	14-XI-35	22	28-XII-35	44
13	24-X-35	13-XI-35	20	22-XII-35	39
14	24-X-35	11-XI-35	18	29-I-36	79
15	25-X-35	17-XI-35	23	13-I-36	57
16	28-X-35	16-XI-35	19	10-I-36	55
17	2-XI-35	19-XI-35	17	6-I-36	48
18	22-XI-35	18-XII-35	26	3-II-36	47
19	23-XI-35	14-XII-35	14	22-I-36	39
20	29-XI-35	16-XII-35	17	3-II-36	49
Minimum			7		39
Maximum			26		95
Average			15.9		53.6

TABLE 6.—*Daily rate of oviposition* [a]

Date of oviposition	Number of eggs deposited by fly									
	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10
VIII-1-32				26						
VIII-2-32		10								
VIII-6-32				11						
VIII-8-32				5						
VIII-9-32			30	40						
VIII-10-32			3							
VIII-11-32	2		2							
VIII-12-32				9	1					
VIII-13-32		15	20							
VIII-14-32		7								
VIII-15-32			21	30	16	45				
VIII-16-32				27						
VIII-17-32			10	8		19	34			
VIII-18-32		10	22	12						
VIII-19-32	19		8	21						
VIII-20-32	22			9		1				
VIII-21-32				7						
VIII-22-32				19						
VIII-23-32	24		32	31	17		24			
VIII-24-32		11				26				
VIII-25-32			39	32						
VIII-26-32			5				12			
VIII-27-32				5		19				
VIII-28-32		7	7	5		9				
VIII-29-32	20			21		18	13		27	
VIII-30-32			19	2	18		7		5	
VIII-31-32			3	11		23	7			
IX-1-32									31	
IX-2-32		17	7	3	1		22		25	
IX-3-32						12				
IX-4-32	21				6	(b)			36	
IX-5-32					25		30		30	13
IX-6-32				19	18		38		27	4
IX-7-32	28			18	12		9	18	31	14
IX-8-32	10		30	2	10				26	
IX-9-32	31		10	40	41		16		43	35
IX-10-32	5	7		28			5	7	5	8
IX-11-32			30				22		27	27
IX-12-32					22			6	25	36
IX-13-32	10						6		20	
IX-14-32	11	8	9	8			8	2		29
IX-15-32								14	12	8
IX-16-32							5	4		
IX-17-32			4				3	2	19	

[a] Flies Nos. 1, 2, and 3 emerged July 22, 1932; No. 4, July 23; No. 5, August 1; No. 6, August 3; No. 7, August 6; No. 8, August 20; No. 9, August 22; and No. 10, August 23, 1932.

[b] Adult fly escaped.

TABLE 6.—*Daily rate of oviposition* [a]—Continued

Date of oviposition	Number of eggs deposited by fly									
	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10
IX–18–32	------	------	------	------	------	------	10	------	------	28
IX–19–32	10	------	------	------	------	------	------	6	4	------
IX–20–32	------	------	8	------	------	------	------	4	------	1
IX–21–32	------	------	------	------	------	------	1	------	------	------
IX–22–32	------	4	23	------	------	------	28	9	28	29
IX–23–32	3	------	2	------	------	------	8	17	13	16
IX–24–32	5	------	------	27	------	------	------	5	------	8
IX–25–32	------	------	8	------	------	------	------	------	14	------
IX–26–32	------	------	------	------	------	------	13	------	------	8
IX–27–32	------	------	------	------	3	------	1	12	10	------
IX–28–32	5	------	------	------	------	------	------	(b)	------	------
IX–29–32	------	------	------	------	------	------	------	------	------	5
IX–30–32	------	------	------	------	------	------	------	------	5	------
X–1–32	------	------	1	------	------	------	------	------	27	------
X–2–32	------	------	8	------	------	------	------	------	------	------
X–3–32	3	2	------	------	------	------	24	------	------	34
X–4–32	------	------	------	------	5	------	------	------	------	19
X–5–32	------	13	1	------	1	------	18	------	------	8
X–6–32	3	------	------	------	(c)	------	------	------	18	11
X–7–32	(c)	3	------	------	------	------	------	------	------	------
X–8–32	------	(c)	------	2	------	------	------	------	------	2
X–9–32	------	------	------	(c)	------	------	3	------	------	------
X–10–32	------	------	------	------	------	------	------	------	2	15
X–12–32	------	------	------	------	------	------	------	------	------	15
X–13–32	------	------	------	------	------	------	c 2	------	------	------
X–14–32	------	------	c 1	------	------	------	------	------	------	------
X–17–32	------	------	------	------	------	------	------	------	------	17
X–18–32	------	------	------	------	------	------	------	------	2	------
X–19–32	------	------	------	------	------	------	------	------	------	8
X–21–32	------	------	------	------	------	------	------	------	------	c 22
X–26–32	------	------	------	------	------	------	------	------	c 2	------
X–27–32	------	------	------	3	------	------	------	------	------	------
XI–3–32	------	------	------	5	------	------	------	------	------	------
XI–4–32	------	------	------	c 1	------	------	------	------	------	------
Total	232	114	363	461	196	172	369	126	494	420
Minimum	2	2	1	2	1	1	1	2	2	2
Maximum	31	15	39	40	41	45	38	18	43	36
Average	12	8	12	14	13	19	27	8	18	16

[a] Flies Nos. 1, 2, and 3 emerged July 22, 1932; No. 4, July 23; No. 5, August 1; No. 6, August 3; No. 7, August 6; No. 8, August 20; No. 9, August 22; and No. 10, August 23, 1932.

[b] Adult fly escaped.

[c] Adult fly died.

TABLE 7.—*Longevity of male and female adult melon fly*

Culture number	Male			Female		
	Date emerged	Date died	Days	Date emerged	Date died	Days
1	4-I-32	19-II-32	46	4-I-32	18-III-32	74
2	5-I-32	22-III-32	77	5-I-32	10-II-32	36
3	18-I-32	23-III-32	65	18-I-32	23-III-32	65
4	26-I-32	25-IV-32	90	26-I-32	25-III-32	59
5	18-II-32	8-V-32	80	18-II-32	18-IV-32	69
6	20-II-32	26-IV-32	66	20-II-32	22-V-32	92
7	21-II-32	8-IV-32	47	21-II-32	15-IV-32	54
8	23-II-32	20-IV-32	57	23-II-32	20-IV-32	57
9	24-II-32	8-V-32	74	15-III-32	29-V-32	75
10	15-III-32	14-IV-32	30	21-III-32	17-V-32	47
11	21-III-32	20-V-32	60	26-III-32	17-V-32	52
12	26-III-32	17-V-32	52	28-III-32	3-VII-32	97
13	28-III-32	27-V-32	60	2-V-32	22-IX-32	143
14	21-V-35	24-VI-35	34	21-V-35	17-VII-35	57
15	24-V-35	11-VII-35	48	24-V-35	17-IX-35	56
16	9-VI-35	27-VIII-35	79	24-V-35	29-VII-35	66
17	29-VI-35	13-IX-35	76	29-VI-35	29-VII-35	66
18	18-VII-35	9-X-35	83	18-VII-35	13-IX-35	76
19	23-VII-35	15-IX-35	54	23-VII-35	9-X-35	83
20	29-VII-35	6-IX-35	39	28-VII-35	20-X-35	84
Minimum			30			36
Maximum			90			143
Average			60.8			70.9

ILLUSTRATIONS

Plate 1

Figure 1. Cross section of patola (*Luffa cylindrica*) showing the egg cavity.
2. Egg, about 14 times.
3. Full grown maggot, about 7 times.
4. Puparium, about 6 times.
5. Adult female melon fly, about 10 times.

Plate 2

Figure 1. Melon flies reared in battery jar, about ⅓ natural size.
2. Fruit fly feeding device (after Peterson) natural size.

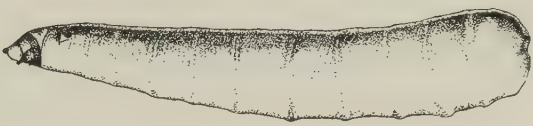
Plate 3

Figure 1. Fresh seeds of amargoso (*Momordica charantia*) destroyed by melon fly maggots, about twice natural size.
2. Abnormal fruits of patola due to the attack of melon fly, about ½ natural size.
3. Abnormal fruits of amargoso due to the attack of melon fly, about ½ natural size.

Plate 4

Figure 1. Longitudinal section of infested amargoso fruits showing the tunnels made by the melon fly maggots, about ½ natural size.
2. Amargoso fruits showing the exit holes made by the maggots, about ½ natural size.

1



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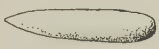

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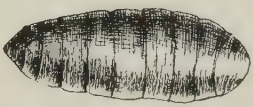

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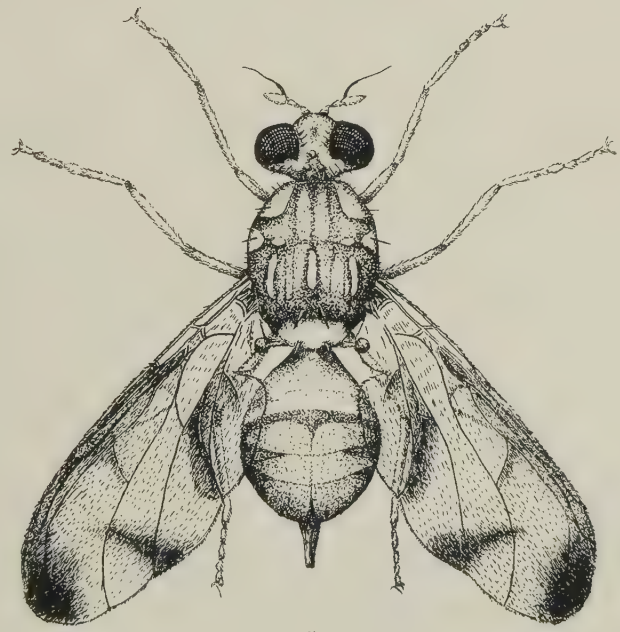

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PLATE 1.

1

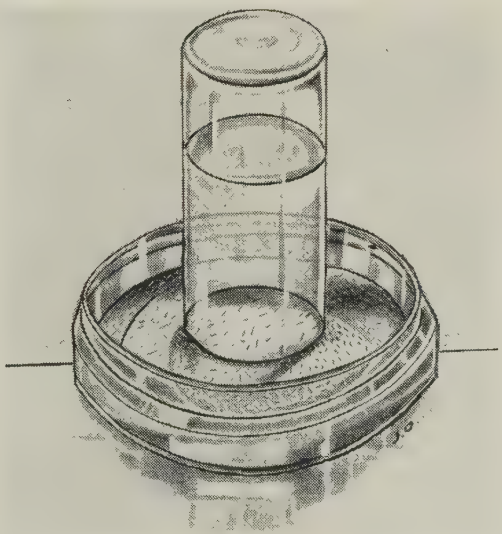

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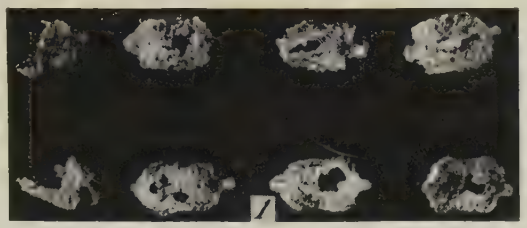
PLATE 2.



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2

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PLATE 3.

PLATE 4.

THE ALUNAN CANE IN THE SUGAR INDUSTRY OF NEGROS

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and

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FIVE PLATES

I. INTRODUCTION

Philippine cane seedling production, so far as the writers are aware of, began only in 1914 when a preliminary work was done at Alabang Stock Farm, then Alabang Experiment Station. This line of work was carried out realizing that not all imported canes thrived well in this country as in their places of origin.

At the Granja Sugar Cane Station (formerly La Carlota Sugar Cane Experiment Station), La Carlota, Occidental Negros, the first attempts at crossing work were made during the crop year 1922–23 and the actual extensive systematic breeding work was started only with the crop year 1924–25. Ever since that period thousands and thousands of cane seedlings were produced out of which only one outstanding strain (La Carlota 25/191) has been selected. It may be mentioned here in passing that this seedling cane has been the result of a tedious and patient work of the late Anselmo Labrador, then Agricultural Assistant of Granja Sugar Cane Station for a period of about 8 years. Up to the year 1932 the Alunan cane was called La Carlota 25/191 and sometimes simply La Carlota. Later, however, the name was changed to Alunan in honor of the then Secretary of Agriculture and Natural Resources, Hon. Rafael L. Alunan.

II. PARENTAGE OF THE ALUNAN CANE

The Alunan cane is a product of a cross between Java 247 and the Badila which was performed during the crop year 1924–

[a] The writers are grateful to Messrs. J. O. Unite and P. A. Honrado, of the Bureau of Plant Industry for reading and criticizing the manuscript.

25. This cross was made with the end in view of combining the desirable characteristics of Java 247 and Badila.

The parents of the Alunan cane have the following salient characteristics:

Badila (*New Guinea 15*).—A cane introduced into the Philippines from Australia in 1912. Of high purity, usually erect in growth. Excellent in ratooning power. Quite resistant to mosaic and Fiji diseases, and highly resistant to smut. Fairly resistant to drought, though growth is of course retarded, giving oftentimes short internodes. This variety is suitable for fertile soils; medium maturing (12 to 14 months). Best harvested in December. Arrows freely in November and December but the points from canes that arrow can still be used as seeds.

Has erect to sometimes sub-erect habit of growth with 3 to 8 millable stalks per stool each from 0.98 to 1.74 (sometimes above 2) meters long, 2.5 to 4.5 centimeters in diameter, and each weighing 1.30 to 3.20 kilograms. Color of stalk, light purple to dark purple. Internodes, short very rarely medium in length; staggered; and tapering at one end (see Plate 2). Tissue, white and medium in texture. Epidermis cracks. Root band has sparse root dots arranged in three rows. Glaucous band heavily (although in some cases slightly) covered with bloom, and the color merges in that of the internodes. Buds large to sometimes medium in size, triangular (though in some instances orbicular), and usually developed on stalk.[1]

Leaves pale green, wide, coarse, relatively lanceolated in outline. Leaf sheaths with stiff deciduous hairs at back. Because of the stiff hairs and coarseness of leaves, same are not good for forage.

Badila has a relatively slow start in growth and therefore needs an early planting, not later than January; preferably earlier as in La Carlota, Isabela, Binalbagan, and Kabankalan districts (Occidental Negros). Because of slow growth, more cultivation is sometimes needed than other varieties that are fast growers.

Cheaper to harvest because of high quality ratio and because of the nature of the cane.

Java 247 (*Bouricious*).—A cane introduced from Java. The plant is sub-erect with 5 to 10 millable stalks per stool each from 1.02 to 2.85 meters long, 1.8 to 3.5 centimeters in diameter

[1] Juan O. Unite and Felix D. Maramba. Bureau of Plant Industry Contributions to Knowledge of Philippine Agriculture, 1931. Bureau of Printing, Manila, 1932, pp. 11–14.

and weighing 0.94 to 1.90 kilos. Stalks vinaceous purple, sometimes light green, light rose, tinged slightly red, light rose predominating. Internodes are long, slightly staggered and cylindrical in shape (see Plate 1). The tissue is white and quite hard in texture. Epidermis does not crack as much as that of the Badila. Root band has numerous root dots scattered indiscriminately. The glaucous band is heavily covered with bloom and the color blends with that of the internode.

Node not raised, internode narrow at middle; bud not well developed.

The buds are small, ovate, and dormant on the stalk.

The leaves are green, medium in width and broadly lanceolated in outline. The leaf sheaths are with deciduous stiff hairs on the back. Leaves are shed.

Arrows in November and December. Canes mature in 12 months. Like Badila, has excellent ratooning power. Slightly susceptible to mosaic but not to Fiji and smut diseases.

Has fairly low fiber content.[2]

III. CHARACTERISTICS OF THE ALUNAN CANE

High purity cane, usually erect similar to Badila in growth. Excellent germinating and ratooning power. Fairly resistant to mosaic and Fiji diseases but highly resistant to smut. Fairly resistant to drought. Suitable to fertile soil like Badila, but grows fairly well in poor soil where other varieties could hardly grow. Cane mature in 12 to 14 months.

Has fairly erect and thrifty habit of growth with 5 to 12 millable stalks per stool each from 1.35 meters to 2.80 meters averaging about 2 meters; weighing from 1 to 2.4 kilos, averaging 1.8 kilos (see Plates 3 and 4). Stalks with much bloom merging all over on internodes.

Stalks, medium to large 3.5 to 4 centimeters in diameter; young stalks purplish to violet; mature ones, dirty purple. Internodes 9 centimeters to 16.5 centimeters averaging 12 centimeters long. Internal tissue solid, cream to brownish. Rind seem slightly harder than Badila and cracks less.

Root band, purplish white when young turning blood red or purplish violet when old; narrow to medium, slightly constricted, with 3 to 4 rows of root eyes scattered indiscriminately, usually 1 to 2 of upper rows remaining dormant.

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[2] Miscellaneous papers on Sugar Cane and Fertilizers. Bureau of Printing, Manila, 1929, pp. 18–25.

Growth ring medium to wide, slightly swollen.

Eye medium to broad, round to sometimes pointed, purplish white with purple rim from base to tip of bud when young, purple when old. Eye germination apical with nervature converting to top.

Joints straight, medium. Internodes fairly cylindrical and medium in length. Nodes narrow; smaller to almost even in diameter to internodes.

Leaf-scar straight, protruding below eye. Wax band conspicuous. Leaves medium to broadly lanceolated, green to light green, rough. Leaf sheath purplish to violet with light green intermingled, clasping tightly to stalk. Hair on back is light and stiff. Aërial roots quite plentiful and prominent.

The only seeming disadvantages of the canes are: (1) plentiful aërial roots as mentioned above, (2) dried leaves do not easily fall. Such characteristics give a slight trouble in harvesting.

IV. PROPAGATION AND DISTRIBUTION OF THE ALUNAN CANE

The first commercial planting was made in 1928–29 by Mr. Luis Jalandoni, a planter of La Carlota district (Occidental Negros) who was the first to see the possibility of the strain. Its established fame began only in 1932–33 when in some haciendas the production reached even as high as 200 to 300 piculs where other varieties hardly reached 180 piculs.

The Alunan cane was distributed for the first time to the public by the Granja Sugar Cane Station in 1927, at first freely, but later a nominal price was charged. From that time, the distribution every year was as follows:

Year	Number of points	Value
1927	5,000	[a] ₱25.00
1928	80,000	[a] 400.00
1929	168,900	422.17
1930	323,900	809.75
1931	914,100	2,285.20
1932	285,600	713.95
1933	168,900	428.17
1934	483,000	1,167.50
1935	5,000	[b] 10.00
1936	594,000	1,188.00
Total	3,028,400	₱7,449.74

[a] Free distribution. [b] Very limited amount for sale.

The following shows the crop years when the Alunan cane was introduced into the different central districts:

	Crop year
1. Palma	1934–1935
2. San Isidro	1933–1934
3. Bearin	1933–1934
4. Binalbagan	1931–1932
5. Isabela	1931–1932
6. La Carlota	1928–1929
7. Maao	1929–1930
8. Lumañgub	1932–1933
9. Bacolod–Murcia	1932–1933
10. Talisay–Silay	1932–1933
11. Hawaiian–Philippine	1932–1933
12. Victorias Milling	1931–1932
13. Manapla Central	1931–1932
14. Lopez C.	1931–1932
15. Leonor	1933–1934
16. Danao	1932–1933
17. San Carlos Milling	1934–1935

V. EXTENT OF CULTIVATION OF THE ALUNAN CANE AS COMPARED WITH OTHER COMMERCIALLY GROWN VARIETIES

For the past 8 to 10 years the per hectare production of the Philippines has been quite low, being less than 60 piculs per hectare. Much of this low yield has been attributed to the use of low yielding native canes. This, indeed, is true with many crops. In recent years, however, most of the canes in the Islands are the so-called new varieties. The POJ 2878, POJ 2883, LC 25/191 (Alunan), Badila, PSA 14, DI 52, Hawaii 109, and some few others are occupying the widest area under cultivation (see Table 1). Mention could be made in this connection that with the showing of the Alunan cane in the different districts especially in Occidental Negros, sooner or later this variety will occupy the widest acreage of all varieties presently grown in the Islands particularly in Negros Occidental. (See figure 1.) Although the commercial planting of Alunan began only in 1928, the variety has occupied a wide area beyond expectation due to its merit aided by the concerted efforts of the Bureau of Plant Industry particularly by the Granja Sugar Cane Station; aided by Dr. A. Gordon of La Carlota Central. (See Table 1.)

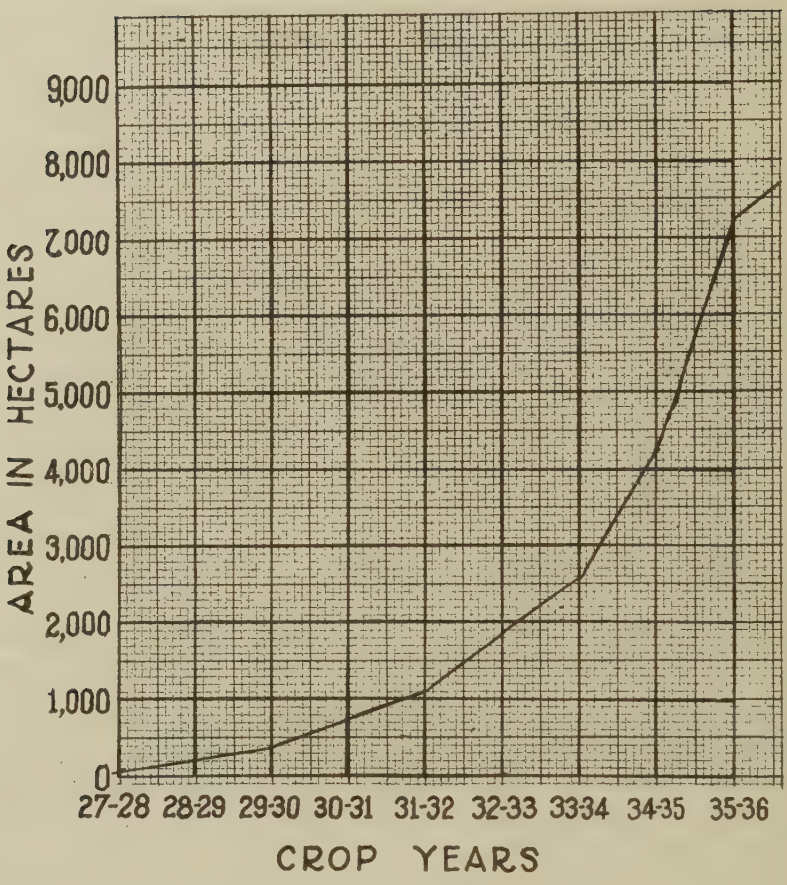

FIG. 1. Showing the trend of La Carlota 25/191 (Alunan) cane planting in Occidental Negros.

VI. PERFORMANCE OF THE ALUNAN CANE AS COMPARED WITH OTHER COMMERCIALLY GROWN VARIETIES

It could be stated that in Occidental Negros, almost invariably, this cane has beaten all other grown varieties (see Tables 3, 4 and 5[3, 4]). In the whole province of Negros Occidental the average tonnage of Alunan for the crop year 1935–36 was around

[3] Reports of chemists, assistant chemists, and chief cane inspector of some centrals.

[4] Alexander Gordon; Annual Report of the Dept. of Agri. and Expts., Central Azucarera de la Carlota, 1936.

TABLE 1.—*Showing the sugar cane acreage by varieties (in percentage) for the crop year 1936–1937 in the different districts*

Central districts	Areas planted by varieties expressed in percentages							
	POJ 2878	Badila	POJ 2883	Alunan	DI 52	Negros purple	Hawaii 109	All others
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
1. San Carlos Milling Co.	90	2	6	0.5	-------	-------	0.5	1
2. Danao Central	50	25	20	2	-------	-------	-------	3
3. Leonor Central	48	25	12	1	2	-------	-------	12
4. Lopez Central	38	25	8	8	-------	2	7	12
5. Manapla Central	59.12	21.52	8.22	6.63	0.54	1.69	1.13	2.15
6. Victorias Milling Co.	57	23.5	8	6.5	1	1	1	2
7. Hawaiian Philippine	50	18	15	5	5	-------	-------	7
8. Talisay-Silay	45	30	12	7	1	2	-------	3
9. Bacolod Murcia	40	35	10	6	6	-------	-------	3
10. Hijos de la Rama	28	36	5	6	20	-------	-------	5
11. Ma-ao Central	23.1	42.7	2.9	6	20.7	1.5	-------	3.1
12. La Carlota Central	16	36	10	30	3	2	-------	3
13. Isabela Central	24	32	2.5	11.5	17	12.5	-------	0.5
14. Binalbagan Central	28	38	5	10	2	6	-------	11
15. Bearin Central	35	28	20	8	5	3	-------	1
16. Palma Central	30	29	20	8	4	6	-------	3
17. San Isidro Central	33	25	25	5	6	-------	-------	6
18. Muscovado Mills (3)	-------	30	-------	3	20	42	-------	5
Total	694.22	501.72	189.62	130.13	113.24	79.69	9.63	82.75
Average	38.57	27.87	10.53	7.23	6.29	4.43	0.54	4.60

NOTE.—The area planted to sugar cane for 1936–1937 is 108,189 hectares including those milled in the muscovado mills.

65 to 66 tons with a quality ratio of 2 piculs per ton cane. An average of around 135 piculs per hectare was registered in the whole province as compared with 115 piculs or less for the other varieties (see Tables 2, 3, 4 and 5). With the area of 7,196 hectares (only in Occidental Negros) for the 1935–36 crop year, this cane yielded about 935,480 piculs, and with the average price of about ₱8 a picul for the year, it gave the province a gross sale of around ₱7,483,840. For the crop year 1936–37 the area covered with the Alunan cane reached over 7,822 hectares in the above-mentioned province.

Mr. Jose Gaton, assistant chemist of Manapla Central, communicating with one of the writers on December 3, 1936, says; "The Alunan cane is doing pretty well in the district (Manapla Central district). There is every probability that a greater portion of the plantations will be planted with this variety in the near future". According to him the Company's records of the

TABLE 2.—*Showing the performance of Alunan cane as compared with other standard varieties*

Centrals	1931–32			1932–33			1933–34			1934–35			1935–36			Average		
	Tons cane per hectare	Purity	Piculs sugar per hectare	Tons cane per hectare	Purity	Piculs sugar per hectare	Tons cane per hectare	Purity	Piculs sugar per hectare	Tons cane per hectare	Purity	Piculs sugar per hectare	Tons cane per hectare	Purity	Piculs sugar per hectare	Tons cane per hectare	Purity	Piculs sugar per hectare
1. San Isidro [a]:																		
Alunan							80	88	160	70	85	120	60	86	120	70	86.3	133.3
POJ 2878	60	83	100	65	81	100	65	81	100	60	80	90	56	81.8	90	61.2	81.4	96
POJ 2883	93	82	150	90	81	135	90	81	135	65	80	100	56	81.8	90	78.8	81.2	122
Badila	65	88	120	55	85	100	55	85	100	63	82	100	55	82	100	58.6	84.4	104
Negros Purple	33	85	60	35	83	60	33	84	60				43	81	70	36	83.3	62.5
DI–52													40	86	80	40	86	80
2. Palma [b]:																		
Alunan										90	88.11	160	72	86.2	120	81	87.2	140
POJ 2878	60	82	90	60	82	90	60	82	90	60	82	90	68	85.05	100	61.6	82.6	92
POJ 2883	90	85	140	90	85	140	90	85	140	90	85	140	75	87.10	125	87	85.4	137
Badila	50	87	90	50	87	90	50	87	90	50	87	90	65	86.5	100	53	86.9	92
Negros Purple	50	87	80	50	87	80	50	87	80	50	87	80	50	84.15	90	50	86.2	82
DI–52													50	85.04	95	50	85	95
3. Bearin [b]:																		
Alunan													73	86.15	100	73	86.15	100
POJ 2878													68	84.30	95	68	84.30	95
POJ 2883													72	86.10	100	72	86.1	100
Badila													65	86.11	90	65	86.11	90
Negros Purple													58	84.15	95	58	84.15	95
DI–52													50	84.06	90	50	84.06	90
4. Binalbagan [a]:																		
Alunan													75	87.12	125	75	87.12	125
POJ 2878													65	84.72	100	65	84.72	100
POJ 2883													75	85.18	120	75	85.18	120
Badila													70	87	100	70	87	100
Negros Purple													58	84	95	58	84	95
DI–52													53	81	80	53	81	80

5. Isabela [c]:																		
Alunan													57	88.66	117	57	88.66	117
POJ 2878													52	86.34	98	52	86.34	98
POJ 2883													60	85.91	109	60	85.91	109
Badila													44	87.54	88	44	87.54	88
Negros Purple													36	86.70	67	36	86.70	67
DI–52													42	89.07	86	42	89.07	86
6. Manapla [b] (only at Hacienda of Centrals):																		
Alunan													64.44		172	64.44		172
POJ 2878													51.45		95	51.45		95
POJ 2883													62.81		105	62.81		105
Badila													53		102	53		102
Negros Purple													53		92	53		92
DI- 52													52		94	52		94
Hawaii 109													53		90	53		90
7. Hacienda Carmiña [d] (Sagay–Escalante District):																		
Alunan													83.17	88	180	83.17	88	180
POJ 2878													85		150	85		150
POJ 2883													83		155	83		155
Badila													65		108	65		108

[a] Data furnished by Chief Chemists of Centrals.
[b] Data furnished by Assistant Chemists of Centrals.
[c] Data furnished by the Chief Cane Inspector.
[d] Data furnished by Manager of Hacienda.

performances of the cane (only Company's haciendas where records are available) are as follows:

Crop year		Production per hectare
		Piculs
1933–1934		145.71
1934–1935		152.16
1935–1936		172.71
1936–1937	(approximately)	179.46

In the report of Dr. A. Gordon of the La Carlota Sugar Central in 1934 he said, "The rapid rise to popularity of variety Alunan which was developed at the La Carlota Sugar Cane Experiment Station from Badila and Java 247 parents has the support of results from variety tests carried out in this district. During this milling season this variety has acquitted itself well in juice qualities and farm returns. This has been fairly heavy tonnage yielding variety and our planters are over-enthusiastic, to say the least." Again, in his 1936 report, he says, "The Alunan cane is now the pet variety in this district (La Carlota) and it is not much to expect that this will be known only through its merit in this district". . .

"The variety Alunan (LC 25/191) has caught the fancy of our planters in this district. The results to date have been gratifying. Its popularity has made it our standard variety for the district."

"The juice analysis of Alunan has been quite steady for sometime now . . . Alunan is now about 30 per cent of the cane crop of La Carlota district." Tables 4 and 5 of Doctor Gordon's annual report are here reproduced showing the performances of the standard varieties in the district of La Carlota.

As could be seen in Table 2, the showing of the variety is indeed heartening in all the districts of the province. The crop years 1935–1936 and that of the present tended more and more to point to the supremacy of the cane—at least as compared to the other standard varieties presently being grown in the province.

The piculs of sugar yield per hectare goes in favor of Alunan for plant canes while in the ratoon POJ 2883 beats the other varieties but is closely followed by the Alunan cane.

TABLE 3.—*Summary results of experiments at Hacienda Parnaso* [a]

Varieties	Crop	Number of replications	Crusher juice			Yield per hectare		Piculs sugar per ton cane
			Brix	Polarization	Purity	Tons cane	Piculs sugar	
Alunan	Plant	10	19.8	18.2	91.9	62.30	138.14	2.22
	Ratoon	10	17.6	15.4	87.0	82.45	147.63	1.79
Totals and averages			18.5	16.6	89.1	144.75	285.77	1.98
POJ 2883	Plant	10	17.8	15.3	85.8	66.12	116.22	1.76
	Ratoon	10	17.9	14.8	82.7	97.79	159.14	1.63
Totals and averages			17.9	15.0	84.0	163.91	275.36	1.68
POJ 2878	Plant	10	17.7	14.9	84.2	45.68	76.58	1.67
	Ratoon	10	17.5	14.7	83.5	88.36	144.47	1.64
Totals and averages			17.6	14.8	83.7	134.04	221.05	1.65
Badila	Plant	10	20.3	18.3	90.0	46.48	101.92	2.20
	Ratoon	10	18.3	15.6	85.1	86.48	153.19	1.78
Totals and averages			19.0	16.5	86.8	132.96	255.11	1.91

TABLE 4.—*Showing averages of yields of five commercially grown varieties in the La Carlota district* [a]

Varieties	Number of tests	Averages from results of variety tests					
		Tons cane per hectare		Piculs sugar per hectare		Piculs sugar per ton cane	
		Plant	Ratoon	Plant	Ratoon	Plant	Ratoon
Alunan	16– 8	82.94 ±3.74	65.25 ±3.63	159.88 ±6.01	130.28 ±4.97	1.96 ±.04	2.03 ±.05
Badila	22–18	70.13 ±2.57	54.57 ±2.10	130.51 ±4.09	106.02 ±3.00	1.90 ±.04	1.97 ±.03
DI–52	6– 5	71.78 ±2.45	56.98 ±2.91	153.55 ±6.18	114.72 ±3.85	2.14 ±.04	1.75 ±.07
POJ 2878	23–15	84.06 ±2.88	72.53 ±2.43	136.17 ±4.91	125.22 ±3.73	1.65 ±.05	1.75 ±.04
POJ 2883	14– 7	91.56 ±4.66	85.29 ±3.97	151.26 ±7.57	150.79 ±5.30	1.68 ±.05	1.79 ±.04

[a] Results obtained by Dr. Alexander Gordon of Central Azucarera de La Carlota.

TABLE 5.—*Comparative performances of the commercially grown sugar-cane varieties at the Granja sugar-cane Station*

VARIETY TEST OF 3 VARIETIES (PLANT CANE) IN 1929–30

Varieties	Brix C. J.	Polarization C. J.	Purity C. J.	Piculs per ton cane	Tons cane per hectare	Piculs sugar per hectare
1. Alunan (LC 25/191)	18.57	16.70	89.90	2.05	74.39	152.50
2. DI–52	18.53	16.70	90.10	2.06	64.69	133.26
3. Negros Purple	16.83	14.23	84.40	1.68	60.62	101.84

RESULTS OF THE 1932–33 AND 1933–34 CROP YEARS UNDER ACTUAL COMMERCIAL PLANTING

Varieties	Tons cane per hectare	Piculs sugar per ton cane	Piculs sugar per hectare
1932–33			
1. Alunan (LC 25/191) [2]	100.14	1.67	167.23
2. DI–52 (plant cane) [1]	86.73	1.62	140.50
3. Labrador (plant cane) [1]	80.49	1.67	134.42
4. Badila (1st. ratoon) [1]	76.77	1.76	135.12
5. POJ 2878 (plant cane) [1]	71.3	1.45	103.39
6. Barbados 147 (plant cane) [1]	62.39	1.66	103.57
1933–34			
1. Alunan (LC 25/191) [3]	85.28	2.165	184.63
2. PSA 14 [2]	86.56	1.98	173.39
3. POJ 2883 (plant cane) [1]	78.295	2.26	176.95
4. Badila (2nd. ratoon) [1]	72.00	2.28	164.16
5. DI–52 (ratoon) [1]	62.86	2.32	145.84

[1] Data on one field of 3 hectares.
[2] Data on one field of 1 hectare in a relatively newly opened field.
[3] Averages of 3 fields of both ratoons and plant canes.

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ILLUSTRATIONS

PLATE 1.

PLATE 2.

PLATE 3.

PLATE 4.

PLATE 5.

PROGRESS REPORT ON REGIONAL ADAPTATION STUDY ON THE PRODUCTION OF CIGAR-WRAPPER LEAF TOBACCO UNDER OPEN CONDITION IN THE PHILIPPINES

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FOUR PLATES

The practice of constructing suitable shades over tobacco plantations in Luzon for the purpose of producing cigar-wrapper leaf of fine-grade involves prohibitive expense, that it is not followed in a big scale. This is especially true when the farmer has a limited amount of capital to invest in cigar-wrapper production. The object of looking for a region or regions where high-grade cigar-wrappers can be grown under open condition is therefore obvious, hence this study reported in this paper.

Trial plantings of the wrapper type of tobacco (Ilagan Sumatra) was conducted at the Davao Penal Colony; at Los Baños Economic Garden, Los Baños, Laguna; and at the Central Experiment Station, Manila during the 1934–1935 tobacco season. The harvest obtained from this preliminary planting showed encouraging results in favor of the Davao Penal Colony products. The planting of tobacco was therefore repeated at Davao Penal Colony only during the 1935–1936 tobacco season and the experiment was conducted under the immediate supervision of the last author.

Using Gutierrez's(1 and 2) finding in Cotabato Valley as a guide as to the best time of the year to plant tobacco and of Gutierrez(2) and Paguirigan(3) for proper distancing of open grown cigar-wrapper leaf tobacco, the author grew tobacco plants in Davao Penal Colony from November, 1935 to April, 1936. The distance of planting used was 50 cm. between the hills and the rows were set at 50 and 80 cm. apart alternately.

SOIL AND CLIMATE

The field selected was newly cleared. The soil is clay loam, deep, friable and rich in humus. The field was traversed by a creek and well drained.

There is no distinct dry and wet season at the Davao Penal Colony. Rainfall is uniformly distributed throughout the year. This is also the condition existing in Medam, Sumatra, where the best grade of cigar-wrapper leaf tobacco is produced. An average of four-year records of the amount of rainfall obtained monthly at Davao Penal Colony and at Medam, Sumatra are given in Table 1.

TABLE 1.—*Showing the mean monthly and annual rainfall at Davao Penal Colony, and at Medam, Sumatra during a period of 4 consecutive years*

Months	Davao Penal Colony, Davao [a]	Medam, Sumatra [b]
	mm.	*mm.*
January	220.2	196.6
February	116.9	83.8
March	203.8	150.0
April	265.2	115.2
May	195.8	213.2
June	232.5	157.0
July	201.6	126.8
August	219.9	178.2
September	159.0	250.6
October	185.9	257.8
November	155.0	302.6
December	82.9	185.0
Annual	2,288.7	2,216.8

[a] Rainfall records were furnished by the Davao Penal Colony employees.
[b] Philippine Journal of Agriculture, Vol. 6. No. 1, 1935.

Variety used.—Ilagan Sumatra variety was used as subject in this study. Under open condition this variety was found best for the production of good cigar-wrapper leaf tobacco. This strain of tobacco was developed at Ilagan from an imported genuine Sumatra variety.

Preparation and sowing of seeds.—Seed beds were prepared near a creek. The land selected for seed beds was plowed and harrowed once, and thoroughly pulverized several weeks before the final lay out of the seed beds. On November 20, 1935, ten beds of 1 x 10 m. were prepared with the use of spading forks, spades, and rakes. Each bed was provided with a shade made of rattan leaves placed about 1 meter above the ground. The shade was inclined to about 25° facing East.

Two-thirds match-full (Rizal Safety Matches box) of tobacco seeds were sown to each seed bed. The seedlings developed were almost rightly distanced so that thinning the seedlings was done only sparingly. Pricking was avoided.

Care of seedlings.—The seedlings were watered occasionally and as often as it was necessary. There was no fungus disease noted on the seed beds. Attention was also directed to the individual seed beds, so that the young plants on them received sufficient sun-light for their needs.

The seedlings were very vigorous as evidenced by the fact that they averaged a height of 15 cm. at the age of 44 days old only. They were very healthy, dark green, and stocky, the characteristics of plants growing in a fertile virgin soil.

Preparation of field.—The field covering an area of 5,850 sq. m. was plowed and harrowed twice. The first plowing and harrowing were done several weeks before the second plowing. On January 7, 1936, when the seedlings were already 15 cm. high, the field was again plowed and harrowed. Furrows for planting were not made. This is not the case in most tobacco regions in Luzon Island.

Transplanting.—Transplanting commenced on January 7, 1936, and continued thereafter until January 11. The seedlings were spaced 50 cms. apart between the hills and the rows were set alternately at a distance of 50 and 80 cms. apart.

Cultivation.—Twenty-three days after transplanting, the plants were cultivated with a plow. Only the 80-cm. spaces were plowed and the broken soil was removed and placed around the tobacco plants on the 50-cm. aisles establishing automatically canals in the 80-cm. spaces. This method of cultivation is called "banking." This practise is advisable only in regions where drainage is necessary, especially so where rain falls very often, as is the case in Davao Penal Colony. When plowing was no longer possible in the plantation, cultivation was done by means of spades and rakes.

Field measurements.—The height of 50 representative plants was taken when the inflorescence was fully exposed. The measurement was observed from the surface of the ground to the tip of the inflorescence. During this time, the number of leaves of each plant was counted and the length and width of the biggest standard leaf developed on a plant were recorded.

Laboratory records.—The diameter of seven pairs of primary veins of 100 cured standard leaves and the thickness of the lamina taken at the middle on both sides of the leaf-blade, halfway from the midrib, were determined with the use of "Perkins micrometer dial gage" graduated to 1/1000 inch. This apparatus was manufactured by B. F. Perkins and Son Inc., Holyoke, Mass., U. S. A.

Harvesting.—The first flower to appear was noticed 46 days after transplanting. Because the curing shed was not yet ready at that time priming was delayed 4 days, Plate I. The first harvest was made on February 26, 1936. The successive priming of the leaves were taken on March 7, 16, 22, 30 and April 6, 1936. Harvesting the leaves was done only during the latter part of the day when the leaves were free from moisture. Harvested leaves were brought to the curing shed to be poled. The leaves were strung "back to back" and "face to face" with the use of rattan cords ranging in number, from 50 to 60 leaves per cord. Each end of the cord was tied to a pole about 1½ meters long and then hung on the racks to cure.

Curing shed.—The curing shed was made of light materials as bamboo and rattan leaves, Plate II. It measured 14 meters long 8 meters wide and 4 meters high. The shutters were made of rattan leaves. On account of the material used, close fitting of the windows and doors were not possible.

The racks were arranged lengthwise in the curing shed. An ample space was provided for at the middle of the shed for aisle. There were seven layers of racks in each division and spaced 50 cm. apart. The placing of poled leaves to be cured was started from the lower most layer upward. This was followed until all the racks of the first half of the curing shed was filled, after which the same procedure was followed on the other half.

The windows and doors of the curing shed were usually opened between eight and nine o'clock in the morning and were closed at about 4.30 o'clock in the afternoon. Blazers were not used except in one instance when the humidity of the air in the curing shed was too high due to heavy rainfall which lasted one whole day. Under Davao Penal Colony condition and with the kind of curing shed constructed (Plate II) tobacco leaves were cured completely within 26 days after stringing.

Fermentation.—Cured tobacco leaves were immediately put down from the racks and built into small "mandalas." When all the tobacco leaves were cured, the small "mandalas" were put together and a big mandala was built in one of the corners of the curing shed, measuring 8 feet long and 4 feet wide. The maximum temperature recorded after two rebuildings of the mandala was 50° C.

DISCUSSION OF RESULTS AND OBSERVATIONS

The results of this study are presented under two headings. The prevalence of pests and diseases in Davao Penal Colony are taken first and the growth of the tobacco plants and quality of the leaf produced, are discussed next.

PEST AND DISEASES

The tobacco insect pests encountered during the season were the cut-worms, leaf folder, stem borer, bugs and some leaf eating insects.

Cut-worms.—The cut-worms consisted of caterpillars of *Prodenia litura* and *Chloridea assulta,* both belonging to the family Noctuidæ. Both insects were persistent in their attack, starting from the seed beds up to the harvesting period, while the caterpillars of *Prodenia* have extended their damages up to the curing house. Both of them, however, were effectively controlled by persistent hand picking supplemented by dusting, using the arsenate of calcium mixed with "gawgaw". A predator, belonging to the genus *Harpactor,* was in abundance in the field and undoubtedly it had helped, to a certain extent, in the control of the caterpillars. This predator was observed feeding upon newly hatched larvae.

Leaf-folder.—Leaf folder was observed in the seed beds but its progress was checked by hand picking, supplemented by light dusting with calcium arsenate.

Stem-borer.—The tobacco stem borer was observed attacking the newly transplanted plants which were recovering. Its further damage, however, was checked by destroying infested plants including the worm inside the stem and replanting the hills with vigorous and stocky seedlings. The tobacco bug and some leaf-eating insects, like the tobacco *green cricket* and the *katytid,* were not attended to as their attack was not serious. They were either controlled by hand picking or dusting with calcium arsenate and "gawgaw" mixture.

DISEASES

Among the tobacco diseases that were encountered during the season were damping off, mosaic, frog-eye spot, midrib-rot, and green-leaf spot.

Damping off.—This disease appeared only in the seed beds. It was effectively checked by exposing the seedlings to direct

sunshine in the morning, removing the infected seedlings including the soil and filling the hole with new one, regulating the watering of seed beds in order not to allow the rapid growth of the fungus especially during the night, and thinning the seedlings in order to give more aëration.

Mosaic.—This disease was first noticed when the young plants have just recovered. Since replanting was still advisable, all affected plants were removed and were replaced by healthy seedlings. With this method, the disease was checked. However, during the blooming period the disease appeared again but at this time only the top leaves and the suckers were affected. No effort to control the disease was made.

Frog-eye spot.—Frog-eye spot appeared during the latter part of the season. It was not so serious as to warrant any attention to control it. Nevertheless the leaves harboring the spots were removed as a precaution.

Midrib-rot.—The prevalence of midrib-rot was first observed among the unharvested leaves in the field. This was about the middle part of March, 1936. The fungus causing the disease attacked the midribs and veins of the leaves. It also attacked the main stem of the plant entering through the leaf scar. There were only few plants that toppled on account of this disease. Its presence in the plantation is easily detected by the dropping condition of the leaves of infected plants, Plate III, the leaves of whole plant appearing as if wilting. Close examination of plants attacked with this disease had black leaves and soft midribs. The fungus causing this particular disease easily spreads to normal leaves, especially to fresh ones in the curing shed. Care was therefore taken not to bring infected leaves to the curing house. All infected leaves or even the whole plant were gathered and discarded in order to prevent the spread of the fungus.

Tobacco Green-leaf spot.—This malady is gaining importance in all regions of the Philippines raising cigar-wrapper leaf tobacco. The results of the study of Paguirigan *et al.*(4) on the causes of the green-leaf spot corroborates the observations made at the Davao Penal Colony during the trial plantings. Some of the results of their study are quoted:

1. Green-leaf spot occurs all over the Philippines regardless of the type of soil and condition of climate in which the leaf wrapper type is grown. Tobacco plants that are grown under shade of abacá cloth develop green leaf spots easily.

2. The severity of the occurrence of green-leaf spot is directly correlated with the structure of the leaf. It occurs more on the leaves of shaded plants, or plants growing in places with very high humidity.
3. Extremes of weather conditions during the curing process favor the production of green-leaf spot, the shaded leaves being the ones affected most.
4. The primordial cause of green-leaf spot is most likely not pathogenic, but the disturbances of the physiological functions of the cells which are cut short due to premature death of the cells on account of extremes of temperature, abundance of moisture, lack of air, or rapid dehydration of the protoplasm.

In addition to the above findings, it was observed in this study that the age of the leaf when harvested played an important factor in the appearance of the green-leaf spot. Immature leaves besides having undesirable color for wrapper purposes were observed to produce green-leaf spot more readily than leaves harvested at medium age. Leaves at the right stage for harvesting cigar-wrapper leaf tobacco may be detected by the following symptoms: (a) Slight change of leaf texture from pliant to tough, (b) Slight change of color shade of leaf from "live" or dark green to pale green and (c) Slight yellowing of leaf tips and margins.

THE PLANT

The stand of the tobacco plants in the plantation was very uniform as is seen in Plate I. The plants were healthy, stocky and relatively tall, Plate IV. Table 2 shows the relative growth development of 50 tobacco plants.

Growth development.—Table 2 shows that the height of the plants ranged from 147 to 205 cm. with an average height of 182.5 cm. Peralta and Paguirigan(5) also found under Los Baños, Laguna condition, that open grown Ilagan Sumatra attained an average height of 180.6 cm., and the average length and width of fresh standard leaves were 43.5 and 27.0 cm. respectively, breath index 62, with an average of 26.5 leaves per plant. In the Davao Penal Colony the length and width of fresh standard leaves averaged 51.08 and 33.3 cm. respectively, breath index 65.3, with an average of 25.5 leaves per plant. The figures obtained show that although the plants in Davao Penal Colony were a little bit taller, they had fewer number of leaves per plant than the plants at Los Baños. However, Davao plants developed big leaves with high breath index while the leaves of the Los Baños plants were small and had breath index of 3.3 per cent less.

TABLE 2.—*Field data of 50 flowering tobacco plants*

Plant number	Height	Number of leaves per plant	Fresh standard leaves		Breadth index
			Length	Width	
	cm.		*cm.*	*cm.*	*per cent*
1	174	25	49	33	67.34
2	159	26	47	32	68.09
3	173	25	53	33	62.26
4	183	25	46	31	67.39
5	190	26	49	32	65.30
6	200	26	52	36	69.23
7	190	25	55	41	73.21
8	180	25	56	36	64.28
9	190	26	48	32	66.66
10	190	24	48	34	70.83
11	195	26	54	32	59.25
12	190	27	60	35	58.33
13	200	27	54	37	68.51
14	190	25	55	35	63.36
15	200	26	52	34	65.38
16	200	24	45	33	73.33
17	205	25	51	33	64.70
18	190	25	52	34	65.38
19	180	24	52	34	65.38
20	190	24	50	35	70.00
21	147	24	47	24	51.06
22	180	27	52	30	57.69
23	170	27	52	27	51.92
24	185	25	50	34	68.00
25	180	24	54	33	61.11
26	175	25	51	32	74.50
27	160	25	50	32	64.00
28	168	24	50	38	76.00
29	170	26	52	30	57.69
30	172	25	50	29	58.00
31	190	25	50	38	76.00
32	180	25	51	34	66.66
33	180	25	54	30	55.55
34	180	27	47	38	80.85
35	180	25	53	30	56.60
36	185	27	50	37	74.00
37	180	25	51	26	50.98
38	180	25	50	27	54.00
39	175	25	53	30	56.60
40	170	24	47	24	51.06
41	201	28	54	40	74.07
42	180	24	48	33	68.75
43	147	26	56	39	69.64
44	180	25	52	34	63.38
45	190	26	52	35	67.30
46	202	26	51	33	64.70
47	180	31	49.5	37	74.00
48	190	27	48	35	72.91
49	190	26	50	35	70.00
50	190	25	50	34	68.00
Average	182.5	25.5	51.08	33.3	65.35

The leaves of the tobacco plants in the Central Office, Manila, were shorter and narrower than the leaves of the tobacco plants grown in Los Baños. It is obvious therefore that they were also poorer than those grown in Davao Penal Colony.

The differences in the growth development and especially in the quality of the leaves produced in these three places tried were to a certain extent due to the influence of the climate prevailing in the region. Table 3 shows the quality of tobacco leaves grown in Los Baños, Laguna; Central Office, Manila; and Davao Penal Colony, Davao.

TABLE 3.—*The quality of open grown cigar-wrapper leaf tobacco in the Philippines compared with imported Sumatra cigar-wrappers*

Criteria	Location			
	Los Baños, Laguna	Manila	Davao	Medan, Sumatra[a]
Average length of cured standard leaves ____cm__	39.9	30.8	41.0	39.26
Average width of cured standard leaves ____cm__	21.4	17.5	25.8	20.86
Average thickness of lamina _____micron__	73.00	75.0	43.05	38.00
Average diameter of veins _____mm__	0.43	43.0	0.421	0.32

[a] Imported cigar-wrapper.

Peralta and Paguirigan(5) state that "to be a good wrapper the leaf should be—thin—and should have fine veins." Of the open grown cigar-wrapper leaf tobacco raised in Los Baños, Laguna; Central Office, Manila; and in Davao Penal Colony, Davao, the plants grown in Davao produced the finest veins and the thinnest lamina (Table 3) but still the leaves were 12 per cent (5.05 microns) thicker than the famous imported Sumatra cigar-wrapper. However, the Davao Penal Colony tobacco leaves were 41 and 43 per cent thinner than the leaves of plants grown in Los Baños and Manila respectively.

Weaver and Clements(6) state that "Every plant is a product of the condition under which it grows and is therefore a measure of environment." The absence of a complete set of measurements of habitat factors in those three places tried, the growth development of the plants grown there can be used therefore with relative accuracy as a measure or indicator of the nature of the climate in Los Baños, Laguna, at Manila, and at Davao Penal Colony.

Peralta and Paguirigan(5) showed that when the aggregate effect of aërial environmental factors is not favorable for tobacco plants to transpire fast, the plant develops broad and thin leaves, the desired good qualities of cigar-wrappers. The fact that the leaves of tobacco raised in Davao Penal Colony (Table 3) were longer, broader and thinner than either the tobacco leaves produced at Los Baños, Laguna, and at Manila indicates that the rate of transpiration of the tobacco leaves at Davao was slower than the rate of transpiration of the leaves of plants grown in Los Baños or in Manila. Therefore, the aggregate effect of aërial environmental factors at Davao is not favorable for rapid transpiration for tobacco plants, further indicating that the climate at Davao Penal Colony is more humid than the climate prevailing in Laguna or in Manila. Under this condition, Davao Penal Colony is a suitable place for raising open-grown cigar-wrapper in the Philippines.

Production and Cost.—From an area of 5,850 sq. m. an actual crop of 19 quintals of tobacco leaves was realized. Out of the total crop, 84 per cent were good cigar-wrappers and 16 per cent were either for binders or fillers. Based from these figures, a hectare would yield 25.2 quintals of good cigar-wrapper and 4.8 quintals for either binders or filler.

The crop (not classified) was sold at public auction at ₱1.35 per kilo by the employees of the Davao Penal Colony, whereas open grown cigar-wrapper leaves raised at Los Baños and at Manila were appraised at ₱0.60 per kilo.(5)

The average total expenditures for the production of ordinary cigar-filler tobacco is about ₱229.80 per hectare. Since the cultural operations of the cigar-filler type and the open grown cigar-wrapper leaf tobacco are almost the same except that at Davao, the "banking method" was adapted which increased the total expenses to ₱100 more, making a total of ₱329.80 per hectare.

Basing from the actual results obtained, a hectare under Davao Penal Colony would give a gross income of ₱1,701 without taking into consideration the cost of 4.8 quintals that were only good for either binder or filler. Deducting the total expenditures of ₱329.80 from ₱1,701 a net gain of ₱1,371.20 would be realized.

SUMMARY

Trial plantings of the wrapper type of tobacco was tried under open condition at Los Baños, Laguna; Central Office, Manila;

and at Davao Penal Colony, Davao during the 1934 to 1935 tobacco season. The results obtained at Davao Penal Colony had the best quality of cigar-wrapper leaf tobacco. The planting of tobacco at Davao was repeated in 1935–1936 tobacco seasons and observations were taken on the prevalence of pest and diseases and the growth and development of the tobacco plants.

Fine grade of cigar-wrapper leaf tobacco was raised at Davao. The size and the color of the leaves produced compare favorably with the famous imported Sumatra cigar-wrapper leaf tobacco. As regards the thinness of the lamina of the leaf, the open grown cigar-wrapper at Davao was only 5.05 microns thicker (12 per cent) than the fine grade imported Sumatra cigar-wrapper leaf tobacco, but the leaves raised at either Los Baños, Laguna and at Central Office, Manila were inferior to that of the Davao Penal Colony production.

A kilogram of not classified cigar-wrapper leaf tobacco raised at Davao, was sold at public auction at ₱1.35 and the Los Baños product was only appraised at ₱0.60 a kilogram. The big difference in the selling price of the crop was mainly due to the thinness of the leaves and its good color, both qualities being the products of the environment of the plant. It is very apparent therefore that Davao Penal Colony has a set of climate favorable for successful growing of open grown cigar-wrapper leaf tobacco.

The monthly rainfall observed at Davao Penal Colony during a period of four consecutive years compare favorably with the mean monthly precipitation at Medan, Sumatra. With this condition and with the use of a good variety of tobacco, cigar-wrapper leaf tobacco can be raised under open condition at Davao Penal Colony with a big margin of profit. In so far as the places tried Davao is the best place, but still it is possible that some other places in Mindanao may be more appropriate for the growing of open grown cigar-wrapper leaf tobacco than Davao. We are still in search of this place.

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ILLUSTRATIONS

PLATE 1

Tobacco plantation (5,850 sq. m.) at Davao Penal Colony, Davao. Note the uniformity of the growth stand of the plants.

PLATE 2

Curing Shed at the Davao Penal Colony constructed at a very low cost.

PLATE 3

Two tobacco plants of Ilagan Sumatra variety affected with midrib rot at the Davao Penal Colony.

PLATE 4

A close up view of open grown Ilagan Sumatra during the first priming period at the Davao Penal Colony.

PLATE 1.

PLATE 2.

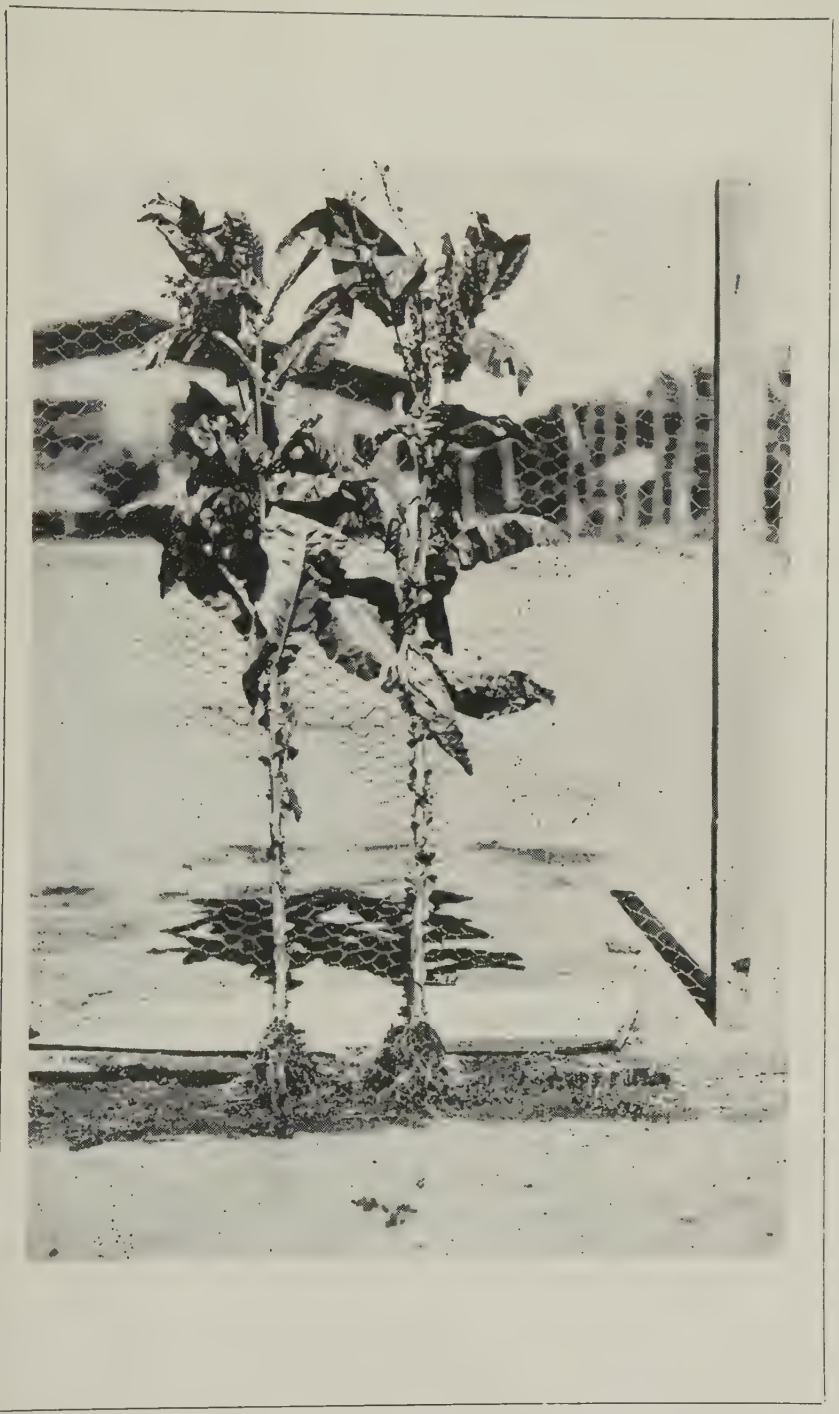

PLATE 3.

PLATE 4.

A NEW RAT TRAP AND HOW TO LAY IT

By Leodegario E. Hachero

Acting Superintendent, Gandara Seed Farm

The general feature of this trap is based upon the principle of pitfall trap construction. Pitfall traps, like pitfall or bascule bridges, have even been used in strategem. In ancient times warring tribes constructed bascule bridges held on hidden springs to trap approaching enemies. In Mindanao the Moros use pitfall traps against their enemies. The Moro pits are dug on roads or pathways and are equipped with missiles such as sharpened stakes planted upright on the bottom of the pit, which is provided with an earthen covering suspended on improvised railings, the surface of which appear as natural as a trodden road. This contrivance is used in a small scale, portable and easier to handle in the war against rats.

The rat is considered one of the most dangerous enemies of man and agriculture. The loss from its ravages, chiefly in the destruction of human foodstuffs and food plants, is enormous. Since time immemorial this fact has been recognized, so science has been resorted to in the fight against this dangerous animal. As a result, modern chemical poisons are used to kill rats, and traps have been invented to reduce destructions by this pest.

Most of the traps now in use are dependent upon a single spring movement, that is, everytime the spring is released, it has to be readjusted before the trap is ready to catch again. The trap described here may be left in a strategic point, without the necessity of readjusting. It gets the victims one after another in succession. It is believed that with the use of this trap and its sub-devices, like the cemented pit in the illustration the hazards experienced with the use of the poisons which are too delicate to handle and dangerous both to human being and domestic animals, would be reduced.

Our rocky hills unfit for agriculture, country canyons, river banks, caves, outcrops of stones, bamboo thickets, alleys of buildings in cities and surroundings of permanent storehouses where rats live can be provided with the kind of bascules (Fig. 1) used in this trap. A little expense for this purpose will insure

crop production against losses due to ravages of rats and reduces the cost and human effort that would have to be spent yearly for the campaign against rats.

LAYING UP THE TRAP

During the dry season, it is the habit of mice to select damp places for dwelling, especially those surrounding the fields of grains, canes, root crops, storehouses or in domestic places. Their presence in the fields may be detected by the signs of small winding paths under the bushes which are frequently littered with grain hulls, straws, and twigs or leaves of herbs. Following these signs, the sides of dikes, banks of nearby rivers or creeks, thickets or outcrop of stones and the surrounding stamps, logs and the foot of the big trees should be searched for holes. Upon discovering the lodging places, the strategic points where to lay the traps are next determined. Generally, these places should be between the grain field and the lodging area. If baiting is contemplated, it is necessary to broadcast the kind of bait available sporadically on the area selected for the traps, at least three days before the traps are finally laid. Roasted corn, copra meat, and dried fish are attractive baits.

At the selected points, holes are dug to fit the tin can pit. The can should be planted in a standing position at such depth that when the detractors (Fig. 1) are placed, the bascules (Fig. 1) are on the same level with the surface of the ground. After setting the can in position, attach the detractor assemblies, the bascules in the cleats (Fig. 2), adjust the levers (Fig. 2, c) to the drawback springs (Fig. 2) and lock the cleats. Level the ground around the can with the counterbalance (Fig. 1) evenly suspended on the ground and the plungers (Fig. 1) at even edges. Water is important here as its depth in the can will prevent the rodent from getting a foothold on the bottom in its effort to leap out. A previously prepared bait such as what was broadcasted a few days before, is dropped inside the can to float on the water. Corrosives or acids may be dissolved in the water to harm the sight of the rodent provided strong scented ones are avoided. Lye is almost odorless when dissolved in water and this may answer the purpose.

In some localities it may become necessary to use a galvanized iron fence which are set in opposite directions or perpendicular to the back of the detractors. This will force the traffic of the rodents to the driveway.

The trap thus laid is visited every morning and afternoon to empty it of its victims. A blacksmith's tongue or the ordinary charcoal tongue may be used to catch the rodents inside the trap. After killing, they are either buried or burnt. Any predacious animal caught alive within that interval of inspection should be turned loose.

The trap can be left in the same place as long as there are catches. Usually the mice stay in the same place as long as left-overs from the harvest exist in the farm. But when the farm is plowed at the advent of the wet season or when the food is depleted or predacious animals become abundant, the hordes move, sometimes in troops, towards the populated places like the barrios, towns and cities, storehouses, or else in search of new places for food supply, like orchards, forests and wild grains in the grassy highlands. This is important to remember, for in so failing, the trapper, may believe that when there is no more rats caught in the traps the situation is controlled.

If their movements are carefully trailed and if the trapper uses good judgment in laying up the traps the work will yield better results.

In areas surrounding farm houses and in towns and cities, the trap can be used to advantage. The place for setting the traps are easily determined and their inspection requires but a short time. Since chickens, cats and small puppies may be caught in the trap, it is necessary to provide a cover for the bascules. The cover is placed at day time and removed at night. If the puppies roam about at night, a fence of slats is constructed and put across the driveway allowing only enough for the rat to pass through.

The rat trap can also be used in the house. If a cut can be made in some part of the house floor where the trap can be fitted, the trap will work.

In washing troughs where rats take a nip at night, the trap can also be used. This will require two pieces of boards, the end of one being placed on the edge of the trough and the end of the other to a railing where the rats pass towards the trough. The other two ends of the two boards must be set apart to leave a space for the trap. The trap is suspended on a char or a box so that the level of the boards and the bascules are even. The trap is left there to work.

In storehouses where grains or foodstuffs are kept, cemented pits as illustrated here can be constructed. The pit should be

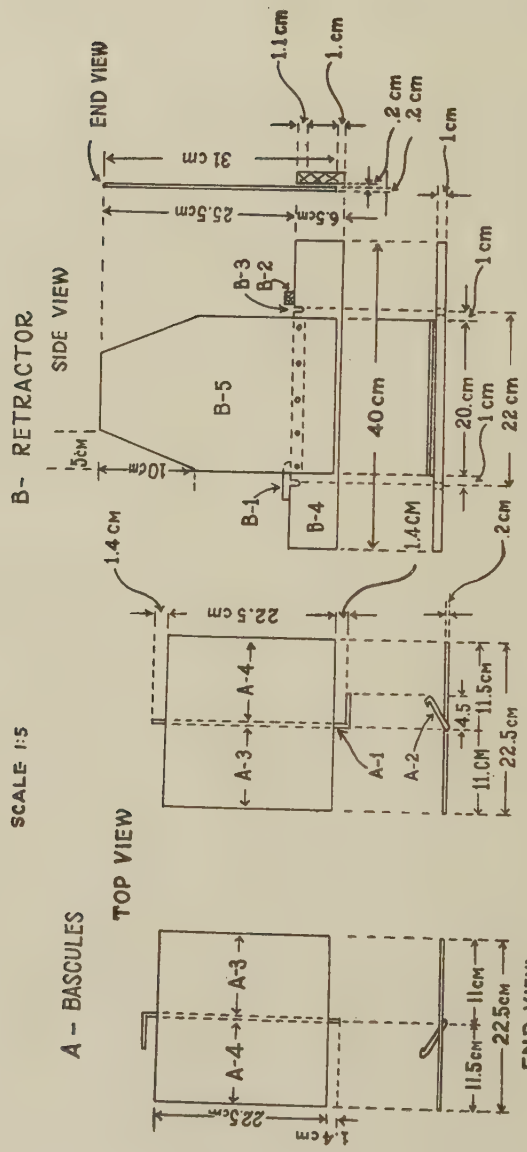

Fig. 1. Plan of bascules and retractor: A-1—Axle, A-2—Lever, A-3—Plunger, A-4—Counterbalance, B-1—Cleat Lock-closed, B-2—Cleat Lock-open, B-3—Cleat, B-4—Cleat Board, and B-5—Retractor wall.

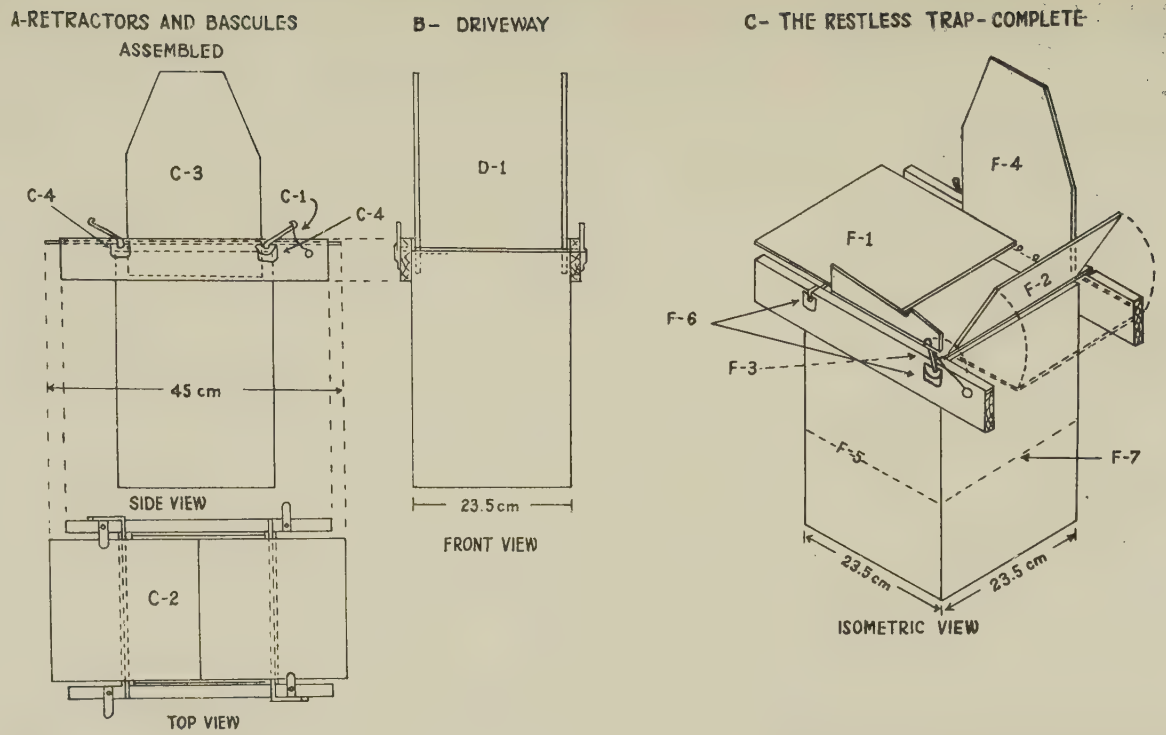

FIG. 2. Plan of retractors and bascules; the driveway; and the trap, complete: C-1—Drawback spring, C-2—Bascules in top view position, C-3—Retractor—Side view, D-1—Driveway, C-4—Axle cap, F-1—Bascule in position, F-2—Bascule in plunging position, F-3—Lever in action, F-4—Retractor, F-5—Tin can pit, F-6—Axle caps, and F-7—Waterline.

set exactly at the corner of the buildings, its length to coincide with the direction of the hiprafter. This position has a general command of any approach to the building. The pit is provided with a shoulder about its brim and about an inch deep. This serves as a hold for the framework conveying the bascule and the detractor attachments. An outlet opening at the bottom is made with an inch pipe. This is for discharging the water when it begins to emit a foul odor. A small pocket hole or a notch is made about the waist side of the pit and provided with a perforated galvanized cover. This is for storing the bait.

A wooden plank made to the size of the framework holding the bascule and detractor attachments is needed. In domestic places the framework is taken off in daytime and the wooden plank placed on the pit to avoid domestic animals and children stumbling into the pit.

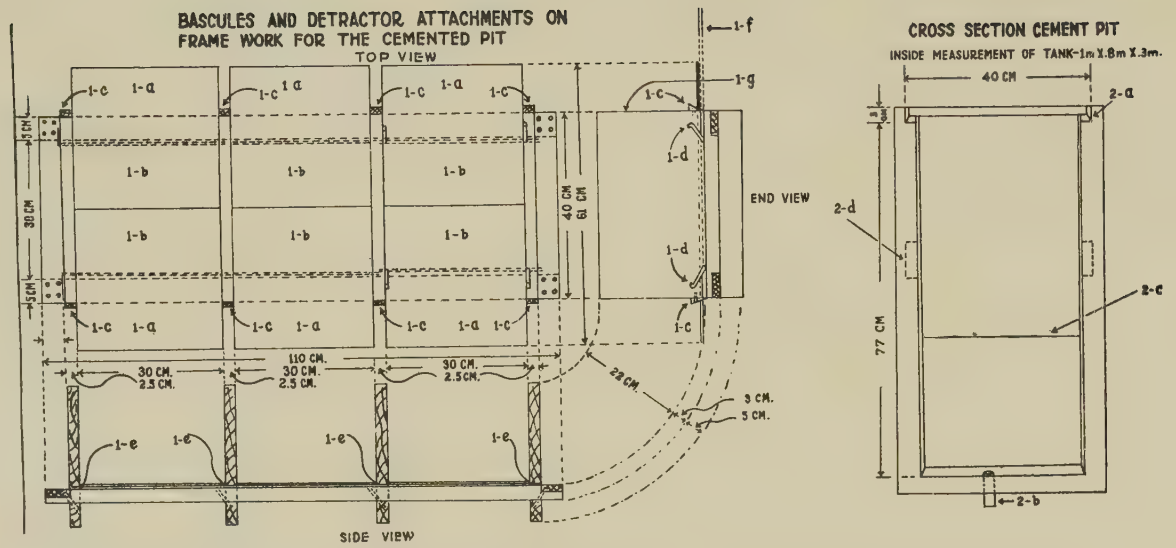

FIG. 3. Bascules and detractor attachments on framework for the cemented pit; and cross section of cement pit: 1-a—Counterbalance, 1-b—Plunger, 1-c—Cleat locks, 1-d—Lever, 1-e—Axle cleats, 1-f—Axle cleat pin, 2-a—Shoulder, 2-b—Outlet pipe, 2-c—Waterline, 1-g—Detractor, and 2-d—Notch for bait.

ILLUSTRATIONS

TEXT FIGURES

FARMERS' CIRCULAR SECTION

GRAPE CULTURE

Farmers' Circular No. 41

By LEON R. AQUINO
Junior Agronomist

One of the many highly priced fruits that is being imported to this country is the grape, *Vitis spp.*, locally known as *uvas* in Spanish, *parras* in Visaya, and *uvas* or *pasas* in Tagalog. Trials to grow this plant have been made in the different regions of the Philippines but with little success, and it is only recently when its culture was undertaken to an appreciable extent by fancy growers.

VARIETIES

Wester (1924) gave the following descriptions of the different species and varieties of grapes introduced into the Philippines or found growing here long ago:

"Grape-Labrusca, Vitis labrusca L. VITACEÆ

"A perennial, woody tendrilled, deciduous vine, indigenous to eastern United States. The leaves are rather thick, dark-green above, downy or velvety beneath, and less cleft than vinifera. The fruits are borne in bunches, and are round, variously colored, sweet, juicy, and of excellent eating quality. The "Isabella" variety has been introduced recently from Hawaii, where it thrives both in wet and dry locations, and is well established in Manila and Zamboanga.

"Grape-Muscadine, Vitis rotundifolia Mx. VITACEÆ

"A woody, perennial vine, with thin, smooth, light green leaves, native of southern United States. The fruits are borne singly or in small bunches, and are thick-skinned and variously colored, with well flavored, sweet flesh. The following varieties have been introduced: Eden, Flowers, James, Labana, Lasalle, Mish, San Jacinto, San Melaska, and Thomas, but the growth at Lamao has not been satisfactory.

"Grape-Vinifera, Vitis vinifera L. VITACEÆ

Local Name: Uvas, Spanish; Parras, Visayan.

"A perennial woody, deciduous, tendril-bearing vine with thin smooth leaves, deeply incised, native of Caucasus to Western

India. The globular fruits are borne in bunches in the axils of the leaves and are variously colored, from green and white to red, purple and black, fleshy, sweet and juicy and of excellent eating quality. A green variety with small bunches and rather juicy fruits is more or less distributed throughout the archipelago, and commonly known as the 'Cebu Grape.' Judiciously pruned it yields good crops. The Spaniards undoubtedly introduced many of their grape varieties of which only the above-mentioned 'Cebu Grape' has gained a permanent foothold and makes a very vigorous growth and strong healthy vines. Many varieties, probably both vinifera and labrusca grapes, were also imported about 1905 by this Bureau for trial at Lamao all of which died within a short time.

"In this case of failures with the grafted plants these may have been due to stocks unsuitable to Philippine conditions and where rooted cuttings were used it might have been due to an inherently weak root system or by being planted where the climatic conditions were altogether uncongenial. It is well within the possibilities that many varieties of grapes would thrive here grafted on the 'Cebu Grape.' Other grape stocks might also be imported to advantage. The highlands of the northern part of Bukidnon would appear particularly adapted to grape culture. In Florida a grape industry is now being built up based on the culture of the following varieties which would appear worth introducing into the Philippines: Armalaga, Brilliant, Carman, Concord, Csaba, Delaware, Ellen Scott, Fern, Goethe, Headlight, Ives, Niagarra and R. W. Munson."

The last species *Vitis vinifera L.*, is considered the most adapted specie in the Philippines. Several varieties are widely grown from northern Luzon to the Visayas and Mindanao and, under what we may still call improper way of culture, they are giving fairly good fruits. In the Visayas, particularly in Oriental Negros and Cebu, the "Cebu grape" and other closely related or identical varieties are found thriving well and producing fairly good fruits with practically very little care. The common practice in these regions is to plant a couple of plants near the house and allow them to cover the porch or small shed in the year which serve for ornamental purposes, while at the same time some fancy fruits are expected in due time. Little cultivation or cultural attention is given to the plants. From the experiences of early growers pruning is being practiced as this has been found to be a prerequisite to make the plant bear fruits.

CULTURE

Grape is propagated by cuttings, marcotting and layering. It can also be grafted on suitable stocks. Seeds from fresh fruits also germinate but vegetative propagation is recommended, as the plant will come into bearing much sooner than the seeds and there is less chance for variations from the parent plant. Propagation by cutting is more commonly practiced than either marcotting or layering.

Medium-matured to matured vines with good buds are best suited for cutting purposes although immature cuttings also give some percentage of success. Preserving the cuttings in moist sphagnum moss for a period of ten to fourteen days was found by the writer to give a higher percentage of success than when they are immediately planted after cutting from the mother plant. Cuttings may be planted either direct on the permanent place or on nursery plots. In the first case proper protection from the excessive heat of the sun is to be made until the cuttings are well started, that is, when the new shoots are sufficiently matured and there are already well-established root systems. Cuttings propagated in the nursery are transplanted after they are also well started.

Grapes thrive best in light fertile soil with good drainage. They may be grown in any ordinary soil, but proper drainage has to be provided for in case this is necessary. In case the soil has poor fertility complete fertilizer may be applied as in any other plant if good production is to be expected.

Grape vines are always provided with trellis or shed (*balag*) for support and on which their branches may spread uniformly. Only healthy and equally distributed branches should be allowed to develop. Pruning should start as early as possible to stimulate rapid growth on the desirable vines although the regular pruning should be done on well-developed plants after about a year. In some places layering of grapes are being practiced but the rooted vines are not severed from the mother plants. These rooted vines are allowed to grow on the same shed or are extended to a new shed without disturbing their original position or direction. For this purpose only the overhanging vines along the sides of the shed that reach the ground are used for layering and the tip branches are again directed to the shed. This way of expanding the area of the vine is recommended if the trellis is low and in a standing position.

In field culture under commercial scale the trellis should be in standing position and each plant should cover a more limited area. Figure 1 shows the arrangements of the trellis and the manner in which the vines should be trained.

In commercial field culture the plants should be set at a distance of 5 meters in the rows while the rows should be 4 meters apart. With these measurements a hectare of land can hold 500 plants. Irrigation facilities should be provided during the dry season if they are available. Likewise, proper drainage should be provided during the rainy season.

The length of the fruiting vines should be maintained during the season or replaced when necessary. Uniform distribution of the vines should also be maintained in order to insure uniform fruiting. Pruning to train the vines should start as early as

FIG. 1. Illustrating the position of the trellis and the arrangement of the vines.

possible and should be done frequently. General pruning to induce fruiting should be done after the plants have attained the age of at least one year. The general pruning is recommended from July to September so that the fruits will mature from November to January. Where the plants are in a condition for pruning at other times, this can be accomplished in the production of out-of-season fruits. Application of complete fertilizer at the rate to be determined according to the condition of the land can be made before the rainy season commences.

Some grape growers believe that grape thrives best and gives good production when located in a place where it receives full sunlight in the morning and partly shaded in the afternoon. This may be true on the lowlands with warm climate during certain seasons of the year, but shades may be dispensed with in high altitudes with cooler climate. Grapes are sensitive to strong wind, hence they should be provided with protection from this.

Pruning.—Grapes must be pruned in order to bring the plants into bearing. Although occasionally we find some vines bearing

fruits without pruning, yet the plants should be pruned regularly to get the expected normal production. Usually the first pruning can be done when the plant is about a year old. Under favorable conditions a single plant must have spread its vines to an area of from 12 to 16 square meters after one year. This, of course, depends upon the conditions of the soil, climate of the locality and the treatment given to the plant. It has been observed that, to maintain a heavy production, the area of the spreading vines should also be limited. From 12 to 16 square meters of equally distributed vines for every plant is considered sufficient.

In pruning grapes all young vines and all leaves are removed. Matured but sickly or undesirable vines are also taken off. Vines of the previous season are considered mature so that those of the latest season are all to be pruned. This can also be determined by the color of the vine. About two to three weeks after pruning new shoots begin to show up with one to four bunches of flowers in every new shoot. The bigger and more healthy the young shoots are, so are the flowers they produce; hence, only the most healthy vines are to be left. The flowers appear at the first to the fourth axils of the first four leaves of the young shoots. It is the practice of experienced grape growers to spare in the next pruning the bases of the last season's growth, one to four nodes, or the region where the last season's fruits appeared. The fruits mature in about ten to twelve weeks from flowering. After the fruits are harvested or while harvesting another pruning may be done for the next fruiting.

Pruning may be done any time of the year. However, if heavy production is expected, the pruning should be done just before or at the beginning of the period of rapid growth of the plant. However, if fruits are desired at certain seasons of the year pruning may be done accordingly. The general principles of pruning should be followed in grapes as in other plants or trees. Pruning in general has the following purposes:

1. To keep the plant well-balanced and well-formed.
2. To give equal distribution of plant food and sunlight.
3. To remove undesirable branches and to prevent serious damages by crowding of branches.
4. To make picking and control of pests and diseases more effective.
5. To thin the fruits.
6. To rejuvenate old trees.

PESTS AND DISEASES

The pests and diseases of grapes observed to be prevalent during certain seasons of the year are as follows:

Bugs.—The bugs appear during the rainy season when the plants are in active growth. The insects eat the leaves at night as in roses and other similar plants. Upon the appearance of the pests the plants may be sprayed or dusted with calcium arsenate. For spraying use 8 to 14 spoons (levelful) of this chemical to every petroleum canful of water depending on the tenderness of the leaves of the plant. The spray should be stirred well while spraying. For dusting, pure calcium arsenate should be mixed with gao-gao in the proportion of one of calcium arsenate to 2 to 10 parts of gao-gao by volume. Spraying or dusting should be done late in the afternoon and should be repeated after every two days until the pests disappear.

Anthracnose.—The disease appears during the rainy season when there is continuous heavy rain. It first appears as scattered spots of rotting or drying on the leaves but later it will cause almost all the leaves to be in rotting or drying condition. This affects also the general growth of the plant. The disease should be sprayed with Bordeaux mixture. If the plant is in the condition for pruning it should be pruned and all the leaves and branches that had been removed should be burned.

PRODUCTION

Under the conditions in Oriental Negros which is practically the average condition in many parts in the Philippines, grapes give fruits any season of the year. With continuous judicious pruning grape vines may produce three times a year. However, to get the maximum production and at the same time maintain the vigor of the plant, pruning and fruiting should take once a year only. Under this condition regular production from year to year may be expected and the plants remain in a vigorous condition to resist pests and diseases and other adversities. Under ordinary conditions a single plant with vines covering about 15 square meters may give a production of from 15 to 25 kilos of fruits in one fruiting season. Under very favorable conditions and with particularly good care the plant may be pruned to induce fruiting more than once a year. Out of season fruits always have the advantage in the market.

Under commercial grape culture the cost of planting and maintenance of one hectare and the production under average conditions in the Islands are estimated as follows:

FIRST YEAR

Expenses.—The expenses for the first year are incurred in the thorough preparation of the land (three times plowing and harrowing and planting to beans or other legumes); cost of planting materials (500 rooted cuttings); staking and planting (plantings could be done even if the field is still planted with legumes); watering and early care and up-keep; cost of materials for trellis; replantings that may be needed; weeding and general cultivation; pruning and control of pests and diseases; and the general up-keep of the plantation. The total expenses at the end of the first year is estimated, under average conditions, at ₱137.00.

Income.—No income is expected at the end of the first year except the harvest from legumes which is not added to income from the principal crop.

SECOND YEAR

Expenses.—The expenses for the second year consist of occasional pruning; cultivation and weeding (4 times a year); the general pruning to induce fruiting; preparation and propagation of cuttings that may be obtained; general up-keep of the plantation; and harvesting and crating of the first fruiting. The first fruiting is expected at the end of the second year if the planting is done at the proper time and proper care given.

Total expenses for the second year	₱30.00
Expenses for the first year	137.00
Total expenses at the end of the second year	₱167.00
Income: At least 200 rooted cuttings should be produced during the second year, valued at ₱0.05 each	₱10.00
At least 100 kilos of fruits are expected at the end of the second year which could be sold (wholesale, at ₱0.40 per kilo	40.00
Total income at the end of the second year	₱50.00
Total expenses up to the end of the second year	₱167.00
Total income at the end of the second year	50.00
Unrecovered expenses at the end of the second year	₱117.00

THIRD YEAR

Expenses.—The expenses during the third year are the same as those of the second year with the increase in the harvesting and crating.

The total expenses is estimated at	₱51.00
Unrecovered expenses at the end of the second year	117.00
Total expenses at the end of the third year	₱168.00
Income: 500 rooted cuttings	₱25.00
At least 1,000 kilos of fruits are expected to be harvested at the end of the third year, valued at	400.00
Total income at the end of the third year	₱425.00
Total unrecovered expenses at the end of the third year	168.00
Net income at the end of the third year	₱257.00

FOURTH YEAR

Expenses.—The expenses during the fourth year are the same as those of the third year with the addition of fertilizer and fertilizer application; repairs of trellis and increase in harvesting, crating and general up-keep.

The total expenses estimated at	₱120.00
Income: 500 rooted cuttings	₱25.00
At least 2,000 kilos of fruits (normal production) valued at	800.00
Total income at the end of the fourth year	₱825.00
Expenses for the fourth year	120.00
Net income for the fourth year	₱705.00

The estimated expenses are based upon average conditions in the different regions of the Islands. The laborers to undertake the work from the start and the maintenance of the plantation are expected to have certain experience along this line or should be under the supervision of an experienced man. The estimates in the production are based upon actual records of bearing vines particularly those found in the province of Oriental Negros. Records of those old grape vines show that productions are obtainable even from plants over ten years old, even without the best care that they should have. Even at the age of over ten years, with proper up-keep of the plantation and the necessary rejuvenation now and then, normal production can still be expected. The success or failure in the production of grapes in a commercial scale depends, of course, upon the adaptability of the plant in the locality and the manner by which the enterprise is to be undertaken from the start.

REFERENCE

WESTER, P. J. 1924. The food plants of the Philippines, Bureau of Agriculture Bulletin No. 39.

BRIEF INSTRUCTIONS ON WEAVING ON HOME-MADE LOOMS

(Farmers' Circular 42)

By Eugenio E. Cruz and Felipe Cortes

Of the Bureau of Plant Industry

ELEVEN PLATES AND ONE TEXT FIGURE

INTRODUCTION

Following the economic slogan of self-sufficiency in prime necessities and the industrialization of raw materials with a view to provide employment as well as to increase the income of the people, the Bureau of Plant Industry has taken the lead in pushing the development of household weaving by improving the looms and studying the possibilities of local fibers for making useful and salable articles.

Household weaving, though a traditional occupation in the Philippines, has not been thoroughly developed and as yet no complete information regarding its operation and scope have been written and brought to the attention of the public. In answer to several inquiries and to guide the provincial pensionados who come to the Bureau of Plant Industry to learn more about weaving and other interested parties, the present paper was prepared.

GENERAL PRINCIPLES

In weaving (see Plate 1) several operations are involved; namely, preparation of heddles and reed, preparation of the yarn, sizing, knotting, spooling, warping, beaming, drawing in, weaving and finishing.

PREPARATION OF HEDDLE FRAME, NEEDLE, HEDDLES AND REED

(*a*) *Heddle frame.*—This consists of two longitudinal pieces of wood supported at the base with stable wood braces as shown in Plate 2. Four pieces of wood are transversely fastened to these two pieces of wood forming parallel bars. The distance from the first and fourth transverse bars must correspond to the length of the desired heddles. The second and third pieces

are so placed between the first and fourth that a hollow space between them is formed. This space serves as the place where the "mail eye" of the heddle is formed. The distance between

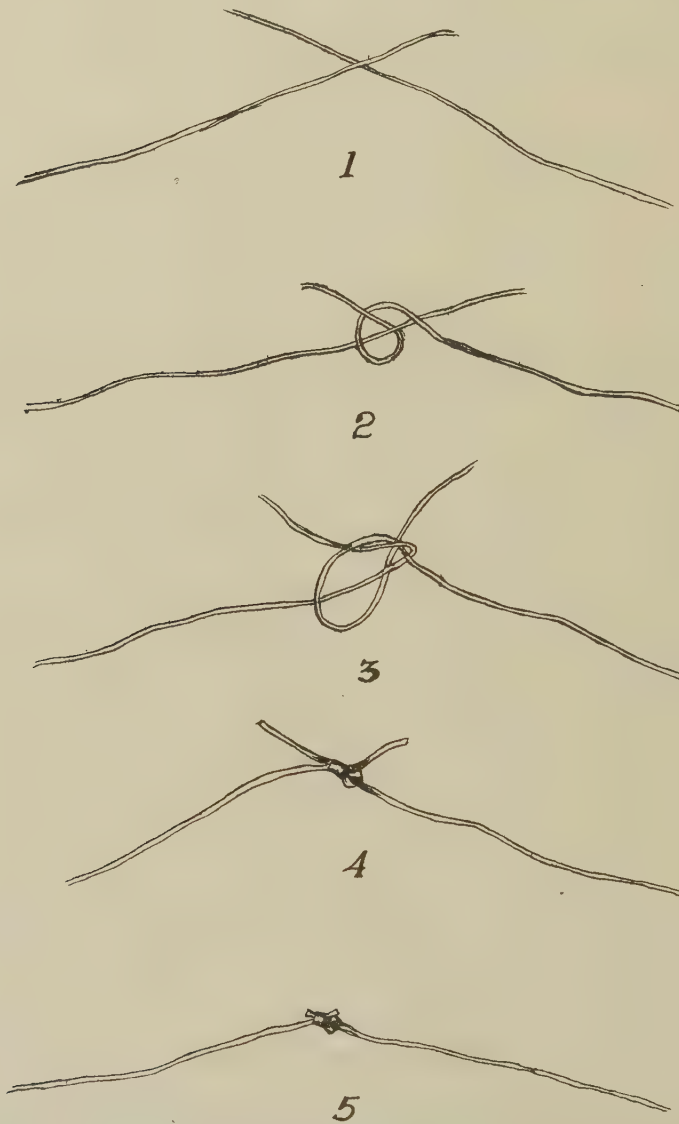

FIGURE 1.—Showing the different steps in knotting abacá, piña, etc. in the Philippines.

these transverse bars varies depending altogether upon personal judgment.

Another heddle frame may be made, such as rectangular frame from four pieces of wood. Another piece equipped with a ridge,

is fastened to the two longitudinal pieces parallel to the two bases serving as transverse bars of the frame. The ridge opening of the middle piece is held in place by a wooden peg fastened to the right longitudinal piece of the frame.

(*b*) *Needle.*—A needle is made of a thin piece of bamboo stick, pointed at one end and depressed at the other (see illustration, Plate 2). At the center of this needle stick a ridge is made in such a way that a thin uniformly rounded splint is formed leaving at its sides a hollow gap which circumscribes its pointed end near the needle's blunt end. Before healds could be made, a considerable amount of threads should first be wound up from the depressed end of the needle to the thin uniformly rounded piece in the ridge.

(*c*) *Heddle.*—Heddles (see Plate 3) are made in various ways. The general principle involved is such that the cord forming a heddle is tied to the heddle frame in a way that an opening at the center through which a warp thread passes is made. This opening or eye is called the "mail eye." The method employed is as follows: With the needle loaded, the thread end is tied at the center bar and drawn forward passing around the lower transverse bar and the back of the frame upward, then winding it again around the top bar forward. A knot is made close to the top edge of the center bar and then another at its under edge. The process is continued until the desired number of healds is made. The top knot in a heald is made by inserting the needle-stick, whose thread forms the front thread, around the back thread forming a loop, then holding both thread and part of the loop adjoining it firmly with the left hand and finally passing the needle through the loop from below embracing part of the loop thread at the same time. Push the loop tightly closed to the top edge of the center bar of the heddle frame, then pull the long end of the thread downward until a perfect knot is formed. The under knot is prepared in the same manner as the upper knot.

(*d*) *Reed.*—The texture and quality of the cloth determine the thickness of the splints in the reed and the dents or spaces formed by them. If the cloth to be woven is coarse the splints in the reed should be wide. The kind and width of the cloth also determine the number and length of splints and dents in the reed, so that more and longer splints and dents are required in making a blanket than in making a towel. In foot-power weaving the splints for reed are usually made of bamboo.

The reed is made by first preparing the splints. The splints must be selected from strong, well-seasoned and thoroughly dried bamboo. They should be of uniform length, breadth and thickness and each provided with a notch for tying at each end. The breadth between the two notches in a splint must be narrower than that from the notch at each end (see Plate 4). Two pairs of bamboo slats are then prepared and set parallel to each other, while a much bigger splint is tied perpendicularly at the end of each pair. This splint fixes the width of the reed. Every splint is inserted through the two pairs of bamboo slats by perpendicularly wedging one notch in between the first pair and the other notch in between the second pair.

The tying at each end of the splint to the parallel pairs of bamboo slats is done by using two needle sticks like that used in making heddles. Each needle stick is first loaded with cotton thread and then tied to one pair of the parallel slats. Then tie each end of the splint by making a counter-clockwise loop around the paired slats. Each time a splint is inserted into the parallel paired slats the two needle sticks also work because there are two ends in the splint to tie to.

PREPARATION OF THE YARN

Ascertaining the amount of cotton yarn to be prepared for warp before attempting to weave any desired fabric is essential in the preparation of the yarn. Usually cotton yarns are bought from the store in the form of hanks. A hank of Nos. 10 and 20 cotton yarn consists always of seven skeins, each skein measuring 120 yards or approximately 110 meters. If there are seven skeins in a hank, therefore, one hank measures 840 yards or 770 meters. It is important for weavers to ascertain the approximate length of a hank as this will enable them to know the number of hanks to be sized for the warp of a desired fabric to be woven. For warp, yarn No. 20 is commonly used, particularly in blanket and towel weaving. For filling, yarn No. 10 in used both for towels and blankets.

In abacá burlap weaving, abacá grade DL, considered as waste, is employed both for warp and filling. The fibers are usually woven dry but since dry fibers become brittle during the process of weaving, rinsing with water from time to time will soften and strengthen them.

Low grade abacá fibers like "J2" and "K" are made into ropes and are also used as warps in the manufacture of rugs and door mats. Sometimes abacá fiber is adulterated with

coir and maguey in door mat weaving, the coir being useful as fillings. Warp yarns may be either dyed or not at all, depending upon the fancy of the producer and consumer.

SIZING

By sizing is meant the starching and brushing to dryness of cotton yarn until ready for spooling (see Plate 5). The principles involved are the thorough penetration of starch grains into each individual thread in the hanks. The purpose is to strengthen the yarn. This is done by beating and brushing the excess starch in the hanks to insure uniformity in the treatment and complete separation into uniform size of individual thread. If the cotton yarns are thoroughly sized, the threads are almost hard, strong and easy to spool. On the other hand, if they are improperly starched the threads stick to each other and are soft, weak and hard to spool.

KNOTTING

Knotting goes hand in hand with spooling (see Plate 6). It is a preliminary process commonly used among the fibers which have not been joined or twisted by machine like abacá, piña, maguey, etc. It is done whenever there occurs a break in the warp threads. In the Philippines, knotting is a time-consuming process for it is done by hand and much time is spent before sufficient amount of yarn is obtained. Knotting is done by placing the ends of the threads to be knotted one above the other so as to form an X. A loop is made with the under-thread around the intersection. At the same time the end of the top-thread is forced into the loop by encircling the intersection with it from above. Then it is pulled from below until a perfect knot is formed.

SPOOLING

Spooling (see Plates 7 and 8) is a process by which the yarn is wound around a bamboo tube by means of a spooler or reeler as shown in Plate 2. Usually the "madejas" or hanks are set on a skeiner supported by a rack or stand as shown in Plates 7 and 8. The end of the first skein, the first of the seven ties in the hank or "madeja," is wound around an empty bamboo tube. This is placed on a spooler which is operated by hand. Spooling is made easier if it begins from the first to the seventh or last skeins. On the other hand, if a thread end is selected at random the threads become crowded and considerable amount of time and thread is wasted.

Knotting abacá, maguey, and piña yarns are spooled not from skeins but from baskets, basin, etc., where the knotted yarn is placed preparatory to spooling.

WARPING

Warping is the process of assembling the required thread strands into parallel order, the number of threads in the warp corresponding to the width of cloth desired (see Plate 9). The length of the warp threads will approximately be the length of the finished cloth minus the waste.

In warping, a series of warp bars about 10 inches long are nailed to two posts as shown in (Plate 5). The yarn to be warped is placed in spools which are always even in number. Warp threads are passed through equidistant paired nails attached to a piece of wood. The threads are taken in pairs preparatory to winding them around the warp bars. This piece of wood through which the threads pass is supported by racks. If there are 20 spools of yarn the thread ends are knotted in pairs so that 10 pairs of thread are gathered and inserted in a crossing or twisting position through the fingers, i. e., one pair of thread is above the other. If there are 10 pairs of threads used, 5 pairs are inserted above and 5 pairs below. From the first warp bar of one post the paired threads are fastened and allowed to pass through two parallel sticks where the crosses or twisted pairs are inserted and then wound around the first warp bar of the second post. The cross or twist formed by the thread pairs becomes the cross of the warp through which two pieces of wood called shed sticks are later fastened during the process of threading. The main function of the shed sticks is to keep the cross of the warp intact. If the cloth to be woven is 18 meters long and the distance from post to post is 3 meters, the paired threads are wound back and forth around the warp bars 6 times or 3 times each way. The threads are then continued until the number of threads corresponding to the width of the cloth desired is set. The other end of the warp yarn may or may not be in place where the paired threads started. This is inserted in the warp bars in a crossing or twisting position in the same way as in the fingers described above. The twist or cross formed here serves as guide for another two pieces of wood which, like the shed sticks, facilitate the arrangement of the warp threads when fastened to the warp roller. The closing of the warp should take place at the post where the

paired threads started and the top pairs knotted with the under pairs around the warp bar where they end.

As soon as the required number of threads is fixed the twists or crosses are tied in place to keep cross of warp intact, and the warp is unraveled first from where the paired threads started and then braided until the end is reached.

The exact amount of hanks of cotton yarn and the required number of threads for the width of the warp are determined by ascertaining the number of dents in the reed. For instance, if the width of the cloth desired is 18 inches and there are 32 dents to the inch in the reed, the number of dents required in the reed is 576 or 18 by 32. But usually in blankets, towels, abacá linen and jusi cloth two threads are drawn in each dent. In towel where 576 dents are needed in the reed the exact number of threads required for the warp should be twice as much or 1,152 threads. If the exact length of the towels to be woven is 18 meters, then 1,152 multiplied by 18 equals 20,736 meters which would be the required length of the cotton yarn. The following may serve as illustration: Since there are 770 meters of yarn in a "madeja" or hank, therefore, the number of hanks required in 20,736 meters would be the quotient of 20,736 divided by 770, or 26.92 hanks which would be necessary as warp of a towel cloth 18 inches wide by 18 meters long. As a safety factor, 1 or 2 hanks are added to 26.92 hanks, depending upon the skill of the weaver in sizing and spooling of the yarn.

BEAMING

Beaming is the winding and spreading of the warp yarn from the warp roller through the warp and the cloth beams (see Plate 10). A piece of stick is passed through the end of the warp where the paired threads during the warping process end and close. This stick is fastened securely at each end to the warp roller with strings or ropes of equal length. This is done to make the drawing in of the warp even throughout. Two pieces of wood are then inserted through the twist or cross. The other end of the warp where the paired threads started is tightly pulled forward by one person while two others keep the warp threads spread uniformly on the warp beam. The spreading of the warp threads on the warp beam is facilitated with the aid of a wood lever which rolls the warp roller clockwise or counter-clockwise.

DRAWING IN

After beaming, the other end of the warp yarn is loosened. Two pieces of stick which serve as the shed sticks are first inserted through the twist or cross and then the ends of the warp threads uniformly cut. The heddles whose number corresponds to the number of threads in the warp are then apportioned equally among the paired shafts. This depends on the number of "leaf healds" or paired shafts containing healds or heddles. The shafts are tied at each end to the warp beam and each thread end of the warp is drawn in each heald through the "mail eye." The operation involved follows carefully the design or pattern in the draft for the cloth to be woven. As soon as all the threads have been drawn in the healds the warp ends are tied into knots or "bouts." Each knot may contain 20, 50 or more threads. A reed containing the required number of dents is tied at each end to the leaf healds or paired shafts. As already described each dent or division in the reed may be inserted with one or two warp threads but in blanket, towel and jusi weaving, usually two threads are drawn in each dent. Having been all drawn in the dents, the warp threads are then tied into knots in the same way as in the leaf healds to keep the warp ends from pulling off the reed. The reed is finally set in the beater.

WEAVING

A double string is passed through each knot and wound around a piece of stick. This stick is gently fastened at each end to the cloth beam with strings or ropes of equal length in order to make the winding of the finished cloth in the cloth beam and the fillings even throughout during the process of weaving. The leaf healds are fastened to the heddle horse which may either be pulleys or wood slats and form the harness of the loom. Usually if there are four pairs of heddle shafts the first and the third pairs are tied to the first treadle, which on stepping lowers down the first and third pairs of heddle shafts. The second and fourth pairs of heddle shafts are also tied to the second treadle. This is true in plain weaving where the filling and warp are almost the same in amount. If the yarn used is coarse, only two pairs of shafts and two treadles are used; but if finer yarn is used, four to eight pairs of shafts are employed in order to make finer weave and to facilitate weaving.

In blanket and towel weaving the number of treadles corresponds also to the number of paired heddle shafts employed and each paired shafts is tied to its corresponding treadle, as heddle

shaft No. 1 to treadle No. 1 and so on. In twill weaving where two pulleys are used on each side, the first and third paired shafts are fastened to one pulley on each end while the second and fourth paired shafts to the second pulley. But Nos. 1, 2, 3, and 4 shafts are also tied to Nos. 1, 2, 3, and 4 treadles, respectively. The shed sticks are then moved backward while those previously inserted during the process of beaming are removed.

Having put the shafts and beater in perfect working order the weaver is ready to weave.

Weaving is the process of interlacing at right angles two or more threads of which the longitudinal is called warp and the transverse weft, or filling. To supply the filling the weaver employs a shuttle which contains a bobbin of threads supported inside with a wire or very thin piece of stick. The weaver throws in the shuttle back and forth transversely through a desired shed or opening in the warp produced by a corresponding step on the treadle. Simultaneously, the filling is driven home by means of the beater. The process of throwing in the shuttle back and forth is called picking and the driving home of every filling with the beater or batten is called beating or battening. The filling threads are called picks and the warp threads ends. Thirty-two ends to the inch means that there are 32 transverse warp threads in one inch distance in the cloth. Thirty-two picks to the inch also means that there are 32 longitudinal filling threads in one inch distance in the cloth. The ends of the fillings forming the edges of the finished cloth is called selvage. A tenter-hook or slat of wood provided with small nails at each end is attached to the finished cloth closed to the unwoven warp to keep the width of the cloth stretched and prevent the weaver from tightly pulling every filling thrown in. The purpose of the beater or batten is to make the filling of the cloth compact, even and solid.

When the finished cloth is to be wound up in the cloth beam and a part of the warp is to be drawn in, a lock consisting of a wheel controlled by a wood working like a lever is released and the hook inserted into a hole of the warp roller, pulled off. The lock and hook keep the warp yarn stretched or loosened when necessary.

The shed sticks are moved backward and forward in the warp. If the weaver desires a wider opening in the warp, she moves the shed sticks backward and vice-versa. The shed sticks keep the cross of the warp intact and enable the weaver to locate

breaks in the warp threads by moving them forward and backward.

FINISHING

When the finished cloth is to be cut while the warp yarn is still long, the warp threads should be cut not too close to the cloth to prevent unraveling of the cloth. Knots are uniformly made at the warp ends to prevent the warp threads from pulling off the reed.

Finished blankets, towels, and jusi clothes need some trimmings before they are marketed. The edges of the blankets and towels must be uniformly and neatly knotted. The excess threads in the design of the jusi clothes should be neatly trimmed.

Plate 11 shows some of the samples of the cloth woven in the Bureau of Plant Industry:

ECONOMICS OF WEAVING

How much does a weaver need to start weaving? This will depend upon several factors. The following information are given for amateur weavers:

MATERIALS NEEDED FOR ONE-PIECE REDSPREAD

Equipment:	
1 Aldaba loom (complete set)	₱50.00
1 Spinner to match	7.00
1 Heddle frame	2.00
Materials:	
1 Bundle No. 20 yarn (white)	4.10
4 Bundles No. 10 yarn (white)	15.60
57 Balls thread, No. 40, at ₱0.02 per ball	1.14
10 Packages starch, at ₱0.05 per package	.50
Total	₱80.34

From the above, 14 blankets each weighing 1.1 kilos and measuring 2.2 meters long by 1.55 meters wide can be obtained. One of these sells at ₱4 in Manila.

MATERIALS NEEDED TO WEAVE JUSI

Equipment:	
1 Malabon loom (complete set)	₱36.00
Materials:	
1 Bundle jusi yarn No. 7	30.00
6 Hanks bleached cotton, at ₱0.40 per hank	2.40
2 Packages dye (Mcdeon, at ₱0.10 per package	.20
8 Balls thread No. 20, at ₱0.02 per ball	.16
10 Boxes Clark's anchor Pearl cotton No. F897, at ₱1.20 per box	12.00
Total	₱80.76

YARNS NEEDED FOR WEAVING THE DIFFERENT KINDS OF CLOTH VARY IN PRICES DEPENDING UPON THE SIZE AND QUALITY

Abacá.—In the Bicol region strips of abacá yarn for sack making are sold at ₱0.04 a kilo. The prices of the plain abacá burlap, F. O. B. Manila are as follows:

	Price per meter
35 cm. wide	₱0.03½
48 cm. wide	.0475
50 cm. wide	.05
65 cm. wide	.07
65 cm. wide (Twill)	.08
65 cm. wide (Double)	.14½

One bale of abacá fiber "CD" costs ₱28 at Manila.

One suit of abacá linen 6 meters long under conditions obtaining in the Bureau of Plant Industry consumed actually 875 grams of mercerized abacá yarn "CD".

Cotton.—Quotations of cotton yarn as given by the different companies on October 14, 1936 were as follows:

MITSUI BUSSAN KAISHA

No. 20—Gray (per bale)	₱148.00
No. 20—White (per bale)	155.00
No. 32—White (per bale)	205.00
No. 40—White (per bale)	215.00

WISE & COMPANY

No. 24—Red yarn (per bale)	₱170.00
No. 30—Red yarn (per bale)	180.00
No. 30—Red yarn (per bale) (Kasa nipa)	165.00
No. 48—Red yarn (Fish and Bull)	120.00

Each bale contains 40 bundles and each boundle weighs 10 lbs.

GOOD MORNING STORE

No. 30—Mercerized (white) per bundle (As of October 14, 1936)	₱11.75
No. 30—Mercerized (white) per bundle (As of December 12, 1936)	13.60

The quotations, weight per head and weight per bundle of dyed mercerized cotton yarn No. 30 from Good Morning Store as of December 12, 1936 are as follows:

Color of yarn	Cost per bundle	Net weight per head	Net weight per bundle
		grams	*grams*
Red	₱14.00	156.6	4,698
Black	14.00	154.3	4,629
Yellow	14.00	148.7	4,461
Rose	14.00	147.3	4,419
Green	14.00	146.3	4,389

BUREAU OF PLANT INDUSTRY

No. 10—Cotton yarn (per bale)	₱3.20
No. 20—Cotton yarn (per bale)	3.60
No. 10—Cotton yarn, bleached (per bale)	4.70
No. 20—Cotton yarn, bleached (per bale)	5.20

There are 20 heads in a bundle of No. 20 yarn. Each head contains 10 "madejas." There are 20 heads also in No. 10 yarn but each head contains only 5 "madejas." In the case of the mercerized cotton there are 20 heads also in a bundle and each head contains 10 "madejas."

To make one blanket 2.2 meters long and 1.55 meters wide, 15 "madejas" of No. 20 as warp and 30 "madejas" of No. 10 as filings are needed.

The cost of production of some of the clothes woven in the Bureau of Plant Industry under experimental conditions are given below:

COST OF PRODUCTION OF ONE-PIECE BLANKET

(1.55 by 2.2 meters)

Materials:	
Cost of 15 hanks needed for warp No. 20 yarn, at ₱0.02	₱0.30
Cost of 30 hanks needed for filling No. 10 yarn, at ₱0.038 per hank	1.14
Labor:	
Sizing 15 hanks (105 skeins) for warp, one-half day, at ₱0.80	.40
Spooling 15 hanks for warp, 2 hrs. at ₱0.10	.20
Spooling 30 hanks for filling, 4 hrs. at ₱0.10	.40
Loading for 1 blanket, 20 min. at ₱0.10 per hr.	.03
Warping yarn for 1 blanket, 1 hr. at ₱0.10	.10
Threading yarn for 1 blanket, 1 hr. at ₱0.10	.10
Reeding yarn for 1 blanket, 1/2 hr. at ₱0.10	.05
Weaving 1 blanket, 1 day at ₱0.80	.80
Finishing 1 blanket, 1/2 day at ₱0.80	.40
Total	₱3.92
Selling price per blanket	₱4.00
Profit	.08

COST OF PRODUCTION OF ONE TOWEL

(18 by 29 inches)

Materials:	
1.28 hanks for warp No. 20 yarn at ₱0.02	₱0.0256
1.6 hanks for filling No. 10 yarn at ₱0.038	.0608
Labor:	
Sizing 1.28 hanks, 1/3 hr. at ₱0.10	.0333
Spooling 1.28 hanks, 1/12 hr. at ₱0.10	.0083
Warping yarn, 1/5 hr. at ₱0.10	.0200

Loading yarn, 1/5 hr. at ₱0.10	₱0.0200
Threading yarn, 1/8 hr. at ₱0.10	.0125
Spooling 1.6 hanks for filling, 1/10 hr. at ₱0.10	.0100
Weaving 1 hr. at ₱0.10	.1000
Sewing 1.5 min. at ₱0.10 per hour	.0024
Total	₱.2929
Selling price per towel	₱.30
Profit	.0071

COST OF PRODUCTION OF ONE METER OF ABATEX

(1/3 cotton and 2/3 abacá)

Cost of materials:	
0.047 kilo cotton at ₱0.80	₱0.038
0.095 kilo abacá at ₱0.90	.086
Labor:	
Preparation of the materials, 1/4 of a day at ₱0.60	.150
Warping, loading, threading and reeding	.071
Weaving, 1/3 day at ₱0.80	.270
Depreciation and supervision	.002
Total	₱0.617

COST OF PRODUCTION PER PILE TOWEL

(22¼ by 35 inches)

Materials:	
1.53 hanks, yarn No. 20 at ₱0.02	₱0.0306
1.35 hanks, yarn No. 10 at ₱0.038	.0513
Labor:	
Sizing, 2.88 hanks, 2/3 hr. at ₱0.10	.0664
Spooling, 1.53 hanks, 1/10 hr. at ₱0.10	.0100
Warping, 2/5 hr. at ₱0.10	.0400
Loading, 2/5 hr. at ₱0.10	.0400
Threading, 1/4 hr. at ₱0.10	.0250
Spooling, 1.35 hanks for filling, 1/12 hour at ₱0.10	.0083
Weaving, 1 towel in 2 hours at ₱0.10	.2000
Finishing, 1½ hrs. at ₱0.10	.1000
Total	₱0.5716

COST OF PRODUCTION OF 6 METERS (1 TERNO) MERCERIZED COTTON

(4 ply filling)

Materials:	
Warp, 2.448 heads No. 30 at ₱0.3916	₱0.960
Filling, 5.02 heads No. 30 at ₱0.3916	1.960
Labor:	
Weaving, 1 woman, 2½ days at ₱0.80	₱2.000
Spooling warp, 2.448 heads, 1 woman, 1½ hrs. at ₱0.10 per hour	.150

Spooling fillings, 5.02 heads, 1 woman 3.26 hours at ₱0.10 per hour	₱0.326
Loading, 1/4 hr. at ₱0.10	.025
Warping, 6 meters long, 1 woman .65 hours at ₱0.10 per hour	.065
Threading, 5 hrs. at ₱0.10 per hr.	.500
Total	₱5.986
Selling price	₱6.000
Gain	.014

COST OF PRODUCTION OF ONE PIECE PATADIONG

(3.5 meters)

Materials:	
2.6 madejas No. 30 for filling at ₱0.0933 per madeja	₱0.242
3.5 madejas No. 30 for warp at ₱0.0933	.326
Labor:	
Spooling, 6.1 madejas for filling and warping, 1/4 hr. at ₱0.1375 per hr.	₱0.039
Warping, 1/2 hr. at ₱0.1375	.068
Loading, 1/4 hr. at ₱0.1375	.039
Weaving, 2 days at ₱1.10	2.200
Threading 2/3 hr. at ₱0.1375	.105
Total	₱3.019
Cost of production per meter of patadiong	₱0.862

COST OF PRODUCTION OF COTTON RIBBON, 23.7 METERS RED, WHITE, BLUE

Materials:	
0.259 grams jusi for filling at ₱29.50 per 3,000 grams	₱0.00254
2.19 madejas mercerized cotton for warp at ₱0.0933 per madeja	.20432
Labor:	
Spooling 2.19 madejas mercerized cotton, 10 min. at ₱0.1375 per hour	.02291
Spooling .259 grams jusi for filling, 50 minutes at ₱0.1375 per hour	.01145
Warping, 1/4 hr. at ₱0.1375 per hr.	.03437
Loading, 1/8 hr. at ₱0.1375 per hr.	.01718
Threading, 3 min. at ₱0.1375 per hr.	.00687
Cost of weaving, 10 days at ₱1.10 per day	11.00000
Total	₱11.29964
Cost of one meter	₱.4767

Jusi.—Jusi yarn Nos. 6 and 7 are sold at ₱30 per bundle. Each bundle weighs 3 kilos and contains 23 heads. They are not in "madejas" like the cotton yarn. From one bundle of jusi yarn No. 6, 50 Camisa de chinos, each measuring 2.6 meters long and 60 centimeters wide, can be obtained. At the rate of

₱2 per Camisa de chino a weaver can therefore get ₱100 from a bundle of jusi yarn No. 6.

COST OF PRODUCTION OF ONE JUSI CAMISA DE CHINO

(63 × 275 centimeters)

Warp yarn 34 grams or 1/4 head at ₱0.01	₱0.34
Filling yarn 44 grams or 1/3 head at ₱0.01	.44
D. M. C. thread 2½ balls at ₱0.17	.42
Spooling 7/12 heads or 78 grams at ₱0.20	.11
Warping 1/4 head or 34 grams at ₱0.12	.03
Weaving one Camisa de chino	.60
Trimming extra thread or designs	.03
Loading 1/4 head or 34 grams at ₱0.04	.01
Threading, 5 hrs. at ₱0.075	.375
Total	₱2.355
Selling price per Camisa de chino	₱2.50
Difference	.145

COST OF PRODUCTION OF ONE BARONG TAGALOG

Warp yarn, 40.8 grams at ₱0.01	₱0.408
Filling yarn, 54.4 grams at ₱0.01	.544
One "madeja," mercerized cotton at ₱0.07832	.078
Spooling 95.2 grams jusi and 1 "madeja" mercerized cotton	.150
Warping, 40.8 grams	.037
Weaving one Barong Tagalog	.600
Threading, 5 hrs. at ₱0.075	.375
Trimming extra threads or designs	.037
Loading	.010
Total	₱2.239
Selling price	₱2.500
Difference	.261

COST OF PRODUCTION PER ETIQUETA

Cost of .2 gram jusi for warp at ₱29.50 per 3,000 grams	₱0.00190
Cost of .55 grams thread at ₱0.12 per 11 grams	.00600
Cost of spooling, 2 min. at ₱0.1375 per hour	.00458
Cost of weaving, 5 min. at ₱0.1375 per hr.	.01145
Cost of warping and loading, 3 min. at ₱0.1375 per hour	.00787
Cost of threading, 3 min. at ₱0.1375 per hr.	.00787
Total	₱0.03967

Silk.—Silk yarn No. 32 are sold at ₱13 per kilo.

Rayon.—Imported Japanese Rayon (Art. No. 300) is obtainable in the market at ₱3.80 per kilo. One box contains 6 spools and weighs ½ kilo net. The weight of one spool is 93.4 grams.

Rayon woven with mercerized cotton yarn No. 30 makes a good material for shirts.

COST OF PRODUCTION OF ONE SHIRT, 3 METERS LONG (MERCERIZED COTTON WARP AND RAYON FILLING, SINGLE-PLY)

Materials:	
7.93 madejas No. 30 mercerized cotton for warp at ₱0.07832	₱0.621
147.91 grams rayon at ₱0.0038	.562
Labor:	
Spooling, 7.93 madejas mercerized cotton for warp, 1/4 hr. at ₱0.1375	.034
Warping 3 meters long, 1/2 hr. at ₱0.1375	.068
Threading, 1 hr. at ₱0.1375	.137
Loading 1/5 hr. at ₱0.1375	.027
Weaving, 1¼ days at ₱1.10	1.275
Total	2.724
Cost of production of 1 meter	₱0.908

TO FIND THE TOTAL TIME AND COST OF THE PREPARATION OF ONE BUNDLE COTTON YARN NO. 20

Starching of 1 bundle, yarn No. 20 (200 hanks 1 day at ₱0.80 per day)	₱0.80
Brushing to dryness of 200 madejas, 3 days at ₱0.80	2.40
Spooling of 200 madejas, 5 days at ₱0.80	4.00
Total	₱7.20
Cost of 2 packages starch at ₱0.05	.10
	₱7.30

SUMMARY

Starching	1 day
Brushing	3 days
Spooling	5 days
Total	9 days

ILLUSTRATIONS

PLATE 1

Showing the ordinary method of weaving on an improved Ilocano loom.

PLATE 2

Showing the heddle frame held by the woman with her left hand and needle with the right hand.

PLATE 3

Showing the heddles in place. The woman is apportioning the heddle threads among the eight heddle sticks.

PLATE 4

Showing the reed (*a*) used in weaving cloth not more than 70 centimeters wide and reed (*b*) used in weaving cloth not more than 175 centimeters wide. Reed (*b*) is commonly used in weaving one-piece bedspread.

PLATE 5

Showing the ordinary method of starching and brushing. The woman looking in front with her two hands above the basin is starching. The woman with her back at the camera and handling a coir brush with her left hand in brushing the starched yarn to dryness.

PLATE 6

Showing the woman in actual knotting operation.

PLATE 7

An ordinary method of spooling cotton, silk and jusi yarn.

PLATE 8

Showing the method of spooling cotton yarn in a multiple spooler. Note that it takes only one to operate the three spoolers arranged in one series. This multiple spooler was devised by the senior author.

PLATE 9

Showing the common method of warping. Note the threads from spooled yarns on the floor being pulled out by the woman through equally distanced paired nails above.

PLATE 10

Showing the common method of beaming in the warp yarn. Note the woman arranging and spreading the warp threads on the warp beam while the man at the center helps the woman at his back to keep the warp yarn stretched.

PLATE 11

Showing the samples of finished products woven in the Bureau of Plant Industry.

TEXT FIGURE

FIG. 1.—Showing the different steps in knotting abacá, piña, etc. in the Philippines.

PLATE 1.

PLATE 2.

PLATE 3.

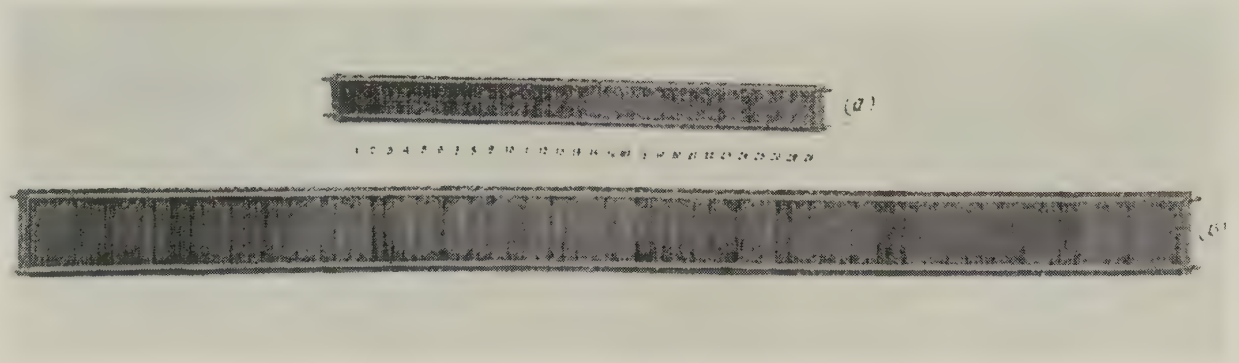

PLATE 4.

PLATE 5.

PLATE 6.

PLATE 7.

PLATE 8

PLATE 9.

PLATE 10.

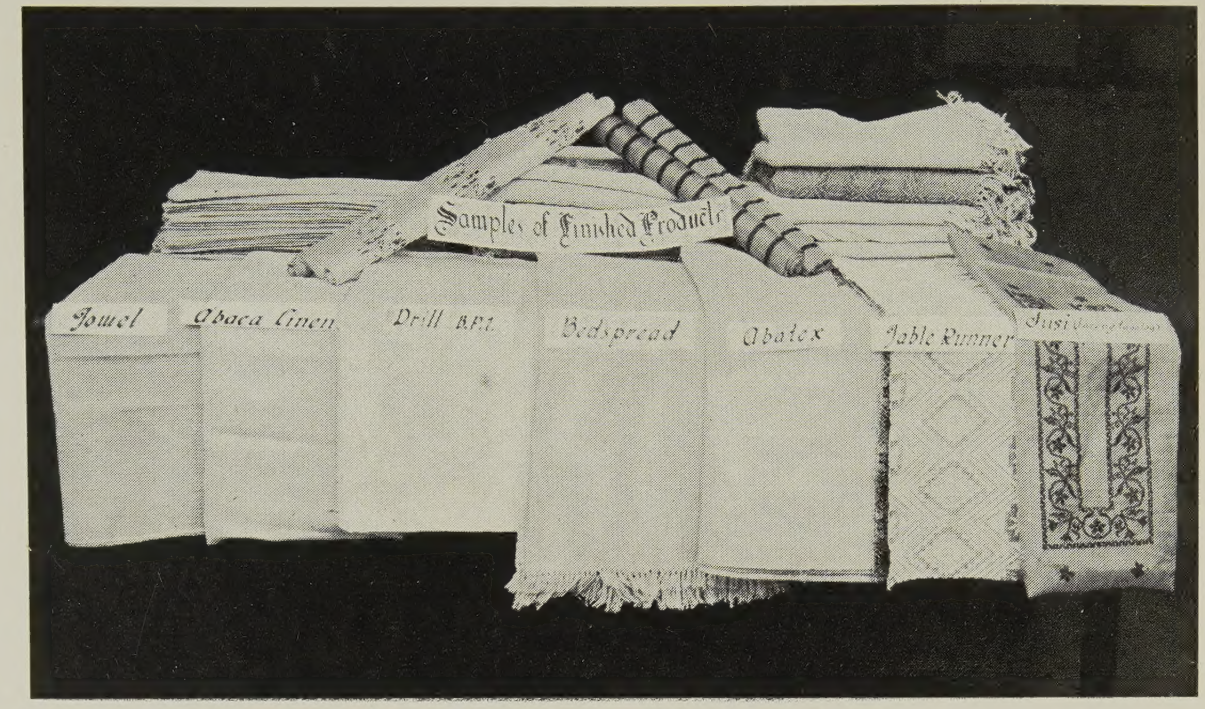
Samples of Finished Products
Jewel
Abaca Linen
Drill B.P.I.
Bedspread
Abalex
Table Runner

PLATE 11.

BUREAU OF PLANT INDUSTRY

AGRICULTURAL STATIONS

1. Central Experiment Station, Manila
2. Lamao Horticultural Station, Limay, Bataan
3. Lipa Coffee-Citrus Station, Lipa, Batangas
4. Tanauan Citrus Station, Tanauan, Batangas
5. Granja Sugar-Cane Station, La Granja, Occidental Negros
6. Gandara Seed Farm, Gandara, Samar
7. Baguio Plant Industry Experiment Station, Baguio, Mountain Province
8. Maligaya Rice Station, Muñoz, Nueva Ecija
9. Ilagan Tobacco Station, Ilagan, Isabela
10. Maridagao Rubber Station, Pikit, Cotabato
11. Moriones Plant Propagation Station, Pili, Camarines Sur
12. La Paz Propagation Station, La Paz, Iloilo
13. Los Baños Economic Garden, Los Baños, Laguna
14. Sta. Maria Propagation Station, Sta. Maria, Ilocos Sur

SUB-STATIONS

1. Davao Seed Farm Project, Davao Penal Colony, Davao
2. Novaliches Mango Station, Caloocan, Rizal
3. Halcon Rubber Station, Baco, Mindoro
4. Gingoog Lanzon Station, Gingoog, Oriental Misamis
5. Mandaue Seed Farm, Mandaue, Cebu

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The articles in the Philippine Journal of Agriculture are indexed in the Agricultural Index, New York, N. Y.

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The journal is issued quarterly. The subscription price is 2 pesos (Philippine currency) or 1 dollar (United States currency) per year in the Philippine Islands and the United States and territories; 2 dollars (United States currency) in foreign countries. Single copies are sold at the same rates.

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